SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XLIV APRIL, 1927—IN TWO PARTS—PART I NUMBER 4

URETEROPYELOGRAPHY[1]

BY WILLIAM F. BRAASCH, M.D., F.A.C.S., AND BENJAMIN H. HAGER, M.D., ROCHESTER, MINNESOTA
Section on Urology, Mayo Clinic

IN the interpretation of shadows in roentgenograms of the urinary tract, the following are the most common causes of confusion: (1) localized areas of tissue calcification, such as calcified lymph nodes, and irregular mottled areas occurring in the renal parenchyma as a result of calcium deposition in renal tuberculosis, in hypernephroma, and in pyogenic abscesses which have undergone resolution with calcification; (2) gall stones; (3) multiple shadows, one or more of which require identification and localization; and (4) the shadows of multiple stones in the kidney not necessarily having similar characteristics, so that, while the shadow of one stone may be typical of renal lithiasis, the other may be suggestive of an extrarenal shadow. Because of the similarity of various shadows seen in the roentgenogram, their exact nature can be determined only by the pyelo-ureterogram.

If the films are clear, the outline of the kidneys can often be seen, and a fair idea of position and size of organs is obtained. Occasionally, with extrarenal tumors or cysts of the kidney, the relationship of the soft shadow cast by the tumor to that of the renal outline can be demonstrated. With horseshoe or fused kidney, the proximity of the renal shadow to the vertebræ, as well as the connecting isthmus, are occasionally shown. Too much reliance should not be placed on the renal shadow, as it is occasionally demonstrated in the roentgenogram when a kidney has been removed. It is possible, therefore, that the shadow is cast by the renal sulcus; at best, shadows of abnormalities in the position and of the size of the kidney, as seen in the roentgenogram, are merely suggestive and must be corroborated by other data. Figure 1 illustrates shadows occurring as a result of calcified renal tuberculosis. Figures 2 and 3 illustrate extensive calcification as a result of renal tuberculosis, resulting in a complete outline of kidney and ureter.

Since the conception by Voelcker and von Lichtenberg, in 1906, that the urinary tract could be outlined by injecting fluid which was opaque to the roentgen rays, urological diagnosis has made tremendous progress. Perfection in the technique of making urograms, employment of comparatively harmless mediums, and wider familiarity with pyelographic interpretation, have established urography as a safe and valuable method in the diagnosis of urinary disease.

With the employment of the halogens as a pyelographic medium much of the danger of pyelography was eliminated. In 1918 an aqueous solution of sodium iodide was suggested by Cameron. Subsequently a solution of potassium iodide was suggested by Rubritius, and a solution of sodium bromide by Weld. These solutions were at first employed

[1]Submitted for publication August 26, 1926.

Fig. 1. Shadows of calcified renal tuberculosis.

in a concentration of 25 per cent, but it was later found that a 12 per cent solution of sodium iodide and a 15 per cent solution of sodium bromide gave a satisfactory outline and caused less local irritation than the more concentrated solutions. In the choice of a medium, the fact that the sodium iodide solution is isotonic to the tissue in lesser concentration than sodium bromide and is consequently less irritating when retained in the renal pelvis probably makes the former preferable.

Probably the most essential technical precaution is against overdistending the renal pelvis. It really makes little difference whether the medium is injected by a hand syringe or by gravity, if ordinary care is used and the injection is stopped as soon as the patient complains of discomfort. It is obvious that the medium employed should be sterile. The sterilization can be accomplished by autoclaving or by dissolving 1 dram of mercuric iodide in 3,000 cubic centimeters of 12 per cent sodium iodide.

A review of the progress made during the last decade reveals that the more general application of urography has added greatly to the recognition of various pathological conditions, particularly changes occurring with calculus, tuberculosis, and tumor, and those incident to ureteral lesions. Cystography has made rapid progress and its value is becoming more generally recognized.

As our experience has increased we have learned to pay more attention to detail and are more apprehensive of artefacts resulting from incomplete distention and blurring. Figure 4 illustrates the significance of the recognition of slight deformities occurring with an otherwise normal appearing pyelogram. The history was that of persistent hæmaturia coming from the right kidney. The same spindle-like deformity extending from the lower major calyx was present in a number of pyelograms. A slight decrease in intensity of the medium in the lower major calyx was likewise apparent in the pyelograms, more so in the first pyelograms. The variation in intensity of medium was attributed to a blood clot. Because of the persistent pain, hæmaturia, and the appearance of the pyelogram, a diagnosis of renal tumor was made and an exploration advised. At operation a lipoma, 2.5 centimeters in diameter, was found on the anterior surface of the kidney, extending down into the renal substance.

Although the deformities seen with various lesions of the kidney and ureter are usually peculiar to the various diseases, thus rendering their recognition possible, nevertheless, the various types of pelvic deformity may so closely resemble one another that their differentiation may be very difficult. In such cases, the personal equation may be a large factor in interpreting the urogram. It is only when the pelvic deformity is clearly depicted and typical of a certain type of disease that diagnosis is advisable. These facts make possible the value and limitations of pyelography, so that interpretation of pyelograms is usually rendered more accurate when compared with all available cystoscopic and clinical data.

Correct interpretation of a pyelogram is based on familiarity with the variations in the outline of the normal pelvis, and unless one is thoroughly familiar with all the possible variations one cannot, of course, recognize de-

Fig. 2. Extensive calcification of renal tuberculosis.

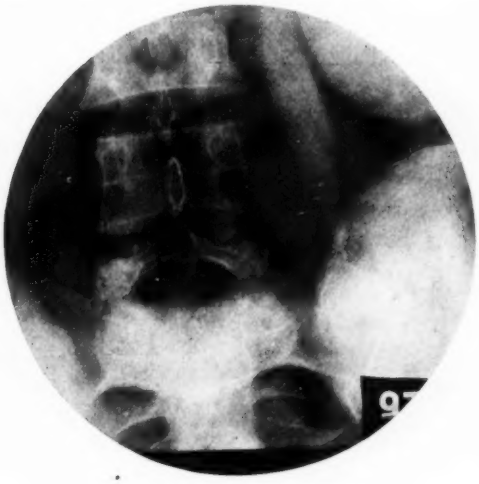


Fig. 3. Same case as in Figure 2.

formity. Figure 5 represents a single type of normal pelvis and portrays distinctly both renal outlines, illustrating the type of pictures that can be obtained by perfected roentgenographic technique.

Elongation of one or more calyces is often observed in the normal kidney, and may be so extensive as to be highly suggestive of neoplasm. However, the outline of the minor calyces will be normal in contrast to the marked deformity usually observed in the minor calyces in cases of neoplasm. Figure 6 is a normal pyelogram showing unusual elongation of the calyces, which might be confused with neoplasm. Although there is slight evidence that the patient moved during the roentgen-ray exposure, the terminal irregularities of the minor calyces are well retained.

The normal pelvis and calyces may occasionally be so large as to suggest early hydronephrosis. In doubtful cases a subsequent pyelogram of the other kidney may be of value, since the outline of both pelves in normal kidneys is usually more or less symmetrical.

Incomplete filling of the pelvis and calyces is a frequent source of error in interpretation. Unless the outline is complete, the apparent deformity may be taken for neoplasm, cortical necrosis, and so forth. On the other hand, as a result of insufficient distention, hydronephrosis, anomaly, and other lesions may be easily overlooked. It is particularly difficult to outline certain renal pelves, as repeated attempts may show. There is a marked difference in the rapidity with which the pelvis empties following distention with the pyelographic medium. If the pelvis is spastic a pyelogram made a short time after distention will usually show the pelvis to be only partially outlined, whereas in other types the medium may be retained and the entire pelvis will be outlined for several minutes after the injection. Blood clots may cause apparent filling defects in the outline, which are suggestive of neoplasm or soft stone.

Another feature which should be considered in interpretation is the effect of previous operation. Postoperative deformity, such as results from removal of stones, fixation of the kidney, drainage, and exploration, is often confusing. As a result, rotation of the pelvis and calyces suggestive of anomaly, deformity of the pelvis, and obliteration or elongation of the calyces, will sometimes occur.

Correct interpretation of the outline of the ureter is particularly difficult and the personal equation plays an important part. The normal ureterogram is subject to greater variation in appearance than is the normal pyelo-

Fig. 4. Slight deformity occurring with renal tumor.

Fig. 5. Renal outlines in normal pelvis.

gram, and it is more difficult to interpret. Normal ureteral peristalsis, as well as the behavior under the influence of stimulation and mechanical irritation resulting from manipulation and injection of the urographic medium, can produce changes in the ureterogram which might be difficult to interpret. So variable are normal ureterograms that uniform ureteral outlines are of more value in establishing accurate diagnoses than are those with doubtful irregularities. A negative ureterogram, therefore, is of greater significance in the exclusion of ureteral lesions than a ureterogram with physiological deformities which may be misconstrued.

It might be stated that, in spite of an ideal medium and every technical precaution, urography should not be made as a routine. There are definite contra-indications, such as: (1) age or great emaciation of the patient; (2) advanced and bilateral renal disease, and (3) the apparent lack of benefit from surgical treatment. The general rule that no instrumentation should be employed in the urinary tract which is not necessary to complete the diagnosis should be strictly observed. Doubtless urography is frequently being employed unnecessarily. It should not be employed to corroborate the diagnosis of conditions such as evident hydronephrosis, renal stone, or renal tumor, and its limitations, together with its indications, should be kept in mind if this form of diagnostic procedure is best to serve the patient as well as the physician.

It should be recognized that pyelography cannot be carried out without some danger to the patient. When the injected medium is retained in the renal pelvis, it may be absorbed into the renal tissue and occasionally cause suppuration. Pyelographic mediums may be retained with pyelectasis from any cause, and particularly with occluding ureteral stone, polycystic kidney, and renal neoplasm. When there is any clinical or cystoscopic evidence suggestive of these lesions, it is advisable to leave the ureteral catheter in position for an hour or more to insure thorough drainage of the pelvis and then to institute lavage with sterile water. If, in spite of this precaution, clinical evidence of acute renal infection should develop, surgical intervention should not be delayed.

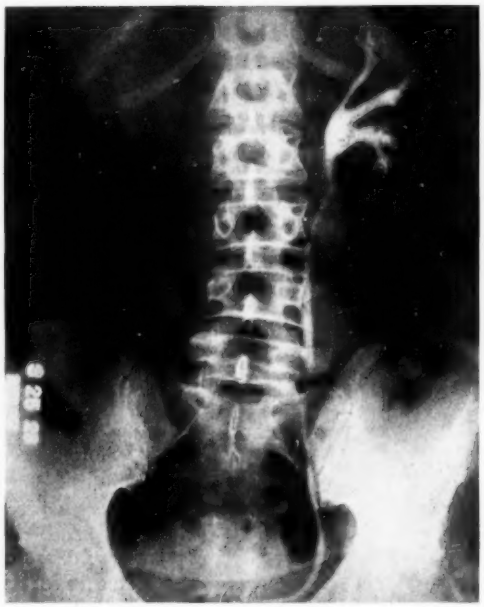


Fig. 6. Normal pyelogram with unusual elongation of major calyces; terminal irregularities of minor calyces well retained.

Fig. 7. Pyelogram, made with patient in horizontal position, showing little evidence of nephroptosis.

The position of the normal kidney is not fixed and it is difficult to place any arbitrary limits on the extent of its change in position. Nevertheless, a marked deviation from the usual position should be regarded as abnormal. Abnormal position of the kidney may be the result of various anatomical conditions, such as renal ptosis, renal torsion, displacement by renal and extrarenal tumor, or ectopic kidney. The position varies, depending on the posture assumed by the patient. The relative position and degree of excursion of the two kidneys may be difficult to ascertain by palpation alone. These data, together with the course of the ureter, may be determined by the pyelogram, which not only shows the relative position of the renal pelvis and relation of the pelvis and ureter, but demonstrates the existence and character of any pathological complication. A second pyelogram with the patient in an erect position may be of value.

Ptosis is more common in the right kidney than in the left, and, when present in both, is usually less marked in the left. The extent of the ptosis can best be described by degree, and may be divided arbitrarily into three grades, slight, moderate, and marked. Evidence of nephroptosis in the pyelogram consists in: (1) variable caudad displacement of the pelvis; (2) rotation or torsion of the pelvis in either a horizontal or perpendicular axis; (3) changes in the angle of the ureter at the ureteropelvic juncture, and (4) tortuous course of the ureter.

Figure 7 is a pyelogram made in the horizontal position; little evidence of nephroptosis is apparent. Figure 8 is a pyelogram of the same patient in a sitting posture, demonstrating marked nephroptosis. This illustrates the value of the urogram made with the patient in the sitting posture, as well as the horizontal, in the recognition of nephroptosis.

Displacement of the kidney as the result of extrarenal or intrarenal pressure is common. The usual causes of such displacement are extrarenal and intrarenal tumors, perirenal abscesses, spinal deformity, and trauma. The displacement may be in any direction and of variable degree. Probably the most common form of displacement is that which occurs

Fig. 8. Same case as in Figure 7. Pyelogram, made with patient in the sitting posture, demonstrating marked nephroptosis.

Fig. 9. Deformity secondary to perinephritic abscess.

with extrarenal tumor, causing caudad displacement of the kidney resembling ptosis. As the result of such pressure there may be considerable deformity and also displacement of the pelvis and calyces, and occasionally it may be difficult to differentiate a renal tumor from an extrarenal. There may be considerable renal displacement as the result of pressure of intrarenal tumor, particularly when there is a large neoplasm in either pole, which may cause considerable displacement of the kidney and pelvis.

Perinephritic abscess, while it usually does not displace the kidney, may do so occasionally either as a result of pressure or cicatricial contraction. Spinal deformity, such as scoliosis and spondylitis, may cause the displacement, which, however, may be more apparent than real.

Figure 9 is an unusual pyelogram resulting from deformity secondary to a perinephritic abscess. Its appearance might easily confuse the condition with neoplasm.

Displacement of the kidney is often accompanied by a variable amount of renal torsion as the result of any of the etiological factors of displacement. Not only is the position of the pelvis altered, but abnormal rotation is frequently observed. Demonstration of renal torsion may be the only evidence of extrarenal tumor, renal injury, or chronic perinephritis. As a result of perinephritis, the pelvis may be fixed in an abnormal position and may be accompanied by considerable renal torsion.

The similarity of pyelograms occurring with torsion and congenital anomaly is very striking, so much so that, without a pyelogram on either side, it might be difficult to differentiate a normal kidney with torsion and rotation from a horseshoe or fused kidney.

DILATATION OF THE PELVIS AND URETER; STRICTURES OF THE URETER

The renal pelvis, as well as the ureter, may become dilated as the result of obstruction and infection.

Obstructive dilatation of the pelvis. If obstruction of the ureter is persistent the portion above the obstruction and the renal pelvis will become dilated to a varying degree, and deviation from the normal will be distinctly seen in the pyelogram. The outline is usually regular, in contrast to the irregularity of inflammatory dilatation.

Because of the retention of urine in the dilated pelvis and calyces, only rounded, scattered areas of portions of these organs

may be seen in the pyelogram. The injected medium may be diluted by the retained fluids so that only a dim area is demonstrated in the pyelogram. The fluid capacity of the normal pelvis is variable, ranging from 5 to 20 cubic centimeters. A pelvis capable of holding 30 cubic centimeters or more is distinctly dilated, so that, if 30 cubic centimeters or more of fluid can be injected into a renal pelvis without evidence of return flow before pain results, it may be safe to infer that some degree of dilatation is present. In view of the fact that occasionally hydronephrosis exists when the pelvic capacity is less than 20 cubic centimeters, and that aspiration of the pelvic content might be confused with a rapid flow of hypersecretion, a pyelogram is of more definite diagnostic value than any other data.

Mobility of the kidney, *per se*, is probably never the sole cause of hydronephrosis. It is only when the kidney assumes a position which permits adjacent tissues to constrict the ureter that hydronephrosis results. The characteristic flabby appearance of the pelvis and calyces frequently observed with ptosis is indicative of dilatation of first degree. Dilatation occurring secondary to stone in the kidney is usually characterized by a predominance of dilatation in the calyces. When the dilatation is greatest in the pelvis, as occurs with the usual type of hydronephrosis, the stone is usually secondary. Occasionally the dilatation may be confined to one or more calyces, leaving the others and the pelvis comparatively normal. The cause of pelvic dilatation by stone is more often inflammation than obstruction.

Anomalous blood vessels causing hydronephrosis usually constrict the ureter a short distance below the renal pelvis. The resulting dilatation may be characterized by wide dilatation of the pelvis and comparatively moderate dilatation of the portion of the ureter above the blood vessel.

It may be inferred from the pyelo-ureterogram that the hydronephrosis and consequent pyelitis in pregnancy is usually due to pressure on the ureter by the uterus. The dilatation is above the point of constriction, which is usually in the middle or lower third of the ureter. Frequently the dilatation may appear

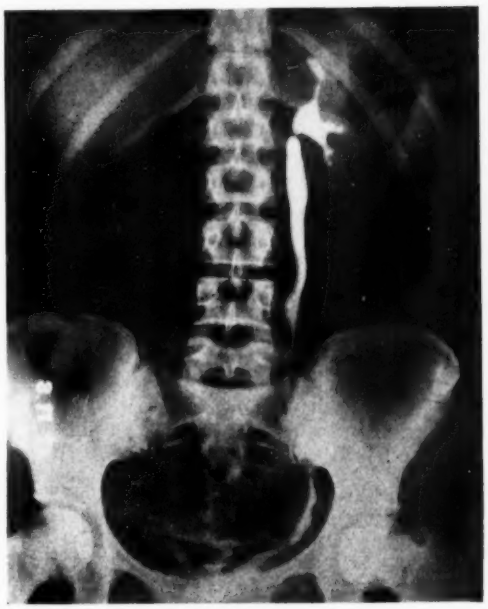


Fig. 10. Renal tuberculosis with evidence of early cortical necrosis and stricture of ureter.

to have both mechanical and inflammatory characteristics. Pyelograms taken several months, or even years, after labor will show the dilatation to be slowly disappearing.

If the distention has not been too great, and if secondary infection is not marked, the dilated pelvis may assume its normal contour in the course of time.

Following operation on the kidneys, various degrees of dilatation of the pelvis and calyces may be demonstrated in the pyelogram. This is frequently noted in kidneys from which stones have been removed, and is probably caused by a residual infection secondary to stone rather than to trauma to the organ at the time of operation. The changes produce a bizarre pyelogram which may be difficult to interpret unless one considers abnormalities that occur from operations on the kidney.

Inflammatory dilatation of the pelvis. Any considerable degree of infection involving the renal pelvis and ureter will be followed by dilatation, the degree depending on the severity of the infection and duration of the symptoms. Evidence of an inflammatory process

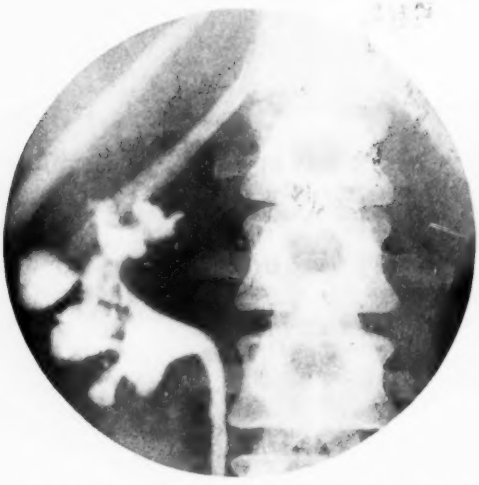


Fig. 11. Advanced tuberculosis with cortical necrosis in all but one of the remaining minor calyces.

Fig. 12. Extensive tuberculous pyonephrosis with tuberculous ureteritis.

is demonstrated in the pyelogram by the following characteristics: (1) obliteration of the terminal irregularities of the minor calyces so that they appear clubbed; (2) dilatation of the calyces predominating over that in the true pelvis, and (3) irregularity of outline of pelvis and calyces. When the process in the pelvis results in marked destruction of tissue, marked dilatation of the entire pelvis may occur, resulting in true pyonephrosis, whereas, when the destructive process is not in balance with the tissue proliferation, there is considerable contraction, resulting in a small atrophic kidney. Urography offers a means of recognizing pyelonephritis and the extent of the process, together with the functional capacity of the remaining renal tissue. When the process has gone on to healing, an old healed pyelonephritis can be readily demonstrated in the outline of the pyelogram.

Pyelonephritis as the result of tuberculosis produces peculiarities in the pelvic deformity which are typical of the disease. While the diagnosis of renal tuberculosis can usually be ascertained by demonstrating the presence of bacilli of tuberculosis in the urine, together with guinea-pig inoculation, clinical data, and cystoscopic examination; nevertheless, in certain cases the history and cystoscopic picture, together with the laboratory data, may be negative, so that pyelography may afford the only evidence of a tuberculous condition. As has been stated, pyelography should not be used when the other data are sufficient for a positive diagnosis.

The changes, in the pyelogram, accompanying tuberculosis are: areas of cortical necrosis, dilatation of the pelvis, obliteration of one or more calyces, and stricture in the ureter. Dilatation and stricture in the ureter are presumptive evidence, while areas of cortical necrosis as seen in the pyelogram are practically pathognomonic of renal tuberculosis. The first evidence of cortical necrosis occurs just beyond the end of the calyces and is characterized by irregular areas of detached medium beyond the outline of the calyces. As the inflammatory process extends, the necrotic areas become larger and may cause irregular shadows adjacent to the pelvic outline, or appear as irregular areas scattered in various portions of the cortex. Again, the areas of necrosis may appear to communicate directly by a narrow isthmus with an irregular outline of the pelvis.

As the inflammatory process advances, the tissue destruction about the pelvis may convert the pelvis and parenchyma into a large

Fig. 13. Congenital atony of the entire urinary tract.

Fig. 14. Ureteral stricture with definite narrowing of the ureter a short distance above the ureterovesical juncture. Definite dilatation of the ureter beyond the point of constriction.

pyonephrotic sac. At times it may be difficult to distinguish between pyelonephritis as the result of pyogenic infection and pyelonephritis as the result of a tuberculous process. As a rule the former is bilateral and the latter unilateral. With pyelonephritis the inflammatory dilatation is usually uniform throughout the calyces. With tuberculosis, unless the process has advanced to the stage in which there is generalized necrosis, one or more calyces are usually involved and show definite cortical necrosis, rather than inflammatory dilatation.

Figure 10 is a pyelogram of renal tuberculosis in which there is evidence of early cortical necrosis. Figure 11 shows advanced tuberculosis with cortical necrosis in all but one of the remaining minor calyces. Figure 12 shows extensive tuberculous pyonephrosis with tuberculous ureteritis resulting in marked narrowing of the upper portion of the ureter.

Dilatation of the ureter. It is often difficult to detect actual dilatation of the ureter in the urogram. Since the normal ureter may distend under pressure, slight dilatation may be more apparent than real. On the other hand, chronic ureteral obstruction, even though moderate, could hardly be present without causing definite dilatation of the ureter or renal pelvis. It should be emphasized that, unless the ureteral dilatation is well marked, it is of doubtful significance. Illustrations of ureteral dilatation appearing in current literature frequently depict a dilatation so slight that a diagnosis of ureterectasis is scarcely warranted.

It may be exceedingly difficult to differentiate dilatation of obstructive and inflammatory origin, and the confusion may be increased by the fact that both causes are present. In general, it may be said that the degree of dilatation resulting from obstruction is greater than that from inflammation and that the outline of the ureter is more regular.

Dilatation of one or both ureters may occur with long-standing infections of the urinary tract, such as chronic pyelonephritis, chronic cystitis, with obstruction in the urethra and

Fig. 15. Stricture secondary to a tuberculous kidney and tuberculous ureteritis.

neck of the bladder, and in lesions of the central nervous system.

The outline of a tortuous ureter, if not completely distended, may give the erroneous impression of multiple strictures. With marked dilatation, the retained urine may dilute the pyelographic medium so that the ureteral outline is indistinct. Only the portion of the dilated ureter adjacent to the obstruction and one or more calyces may be visible. Ureteral obstruction is usually caused by intrinsic and extrinsic factors, such as stricture, lithiasis, external pressure, encroachment on the ureter secondary to an inflammatory process of the female adnexa or adjacent pelvic organs, and obstruction of the lower urinary tract. The ureterogram may aid in determining the cause.

Unilateral or bilateral hydro-ureters may be demonstrated by filling the bladder with 12 per cent sodium iodide solution and allowing it to regurgitate up the ureter. Regurgitation frequently occurs in bladders as a result of cord lesions, and a cystogram portrays clearly the three cardinal findings: (1) large irregular bladder outline with trabeculation; (2) relaxation of the internal sphincter, and (3) regurgitation of medium in either one or both ureters.

Figure 13 illustrates congenital atony of the entire urinary tract. The bladder is markedly dilated; the medium passing unobstructed into the ureter and renal pelvis portrays a large bilateral hydro-ureter and hydronephrosis.

Strictures of the ureter. Probably in no other pathological condition of the ureter is the personal equation such a large factor as in the diagnosis of stricture. The inherent nerve control of the ureter, which is apparent in peristalsis, is subject to local irritation and, as a result, localized areas of spasmodic constriction may cause not only obstruction to the ureteral catheter or bougie, but also variable dilatation above and below it, as is apparent in the pyelo-ureterogram. Ureteral spasm will probably explain many cases of so-called ureteral stricture diagnosed by using ureteral bulbs alone. It may also explain the divergence between such clinical diagnoses and the findings on surgical or postmortem examination.

Strictures of the ureter resulting from infection in the ureteral wall may be single or multiple and may be situated in any portion of the ureter. With a primary stricture in the lower ureter, the resulting dilatation frequently prevents the formation of multiple strictures. When the strictures cause marked narrowing of the lumen of the ureter the diagnosis may be inferred by obstruction to the ureteral catheter. Similar obstruction to the catheter may, however, be caused by some anatomical condition, such as acute angulation in the course of the ureter, and marked elasticity of the ureteral wall. Usually the injected fluid will pass any such obstruction offered to the ureteral catheter, and the absence of dilatation or any evidence of abnormality will demonstrate the anatomical nature of the obstruction.

Figure 14 is a urogram showing stricture of the left ureter. There is definite narrowing a short distance above the ureterovesical juncture, and beyond this the dilatation is definite.

Stricture of the ureter occurring with pyelonephritis may be either single or multiple, and

as a result the ureter is irregularly dilated. If the infection is chronic the strictures are usually multiple, although in the early stages there may be only one for some time, particularly in the lower portion of the ureter.

Stricture of the ureter often accompanies renal tuberculosis. If it occurs in the early stages of the disease the ureter and pelvis may be considerably dilated, and appear more typical of obstruction than infection. Instead of uniform dilatation of the pelvis and ureter, there is usually marked irregularity, with deformity and necrosis of the individual calyces.

Figure 15 illustrates a narrowing of the upper ureter as a result of stricture secondary to a tuberculous kidney and tuberculous ureteritis. Cortical necrosis of the upper and lower major calyces indicative of tuberculosis may be noted.

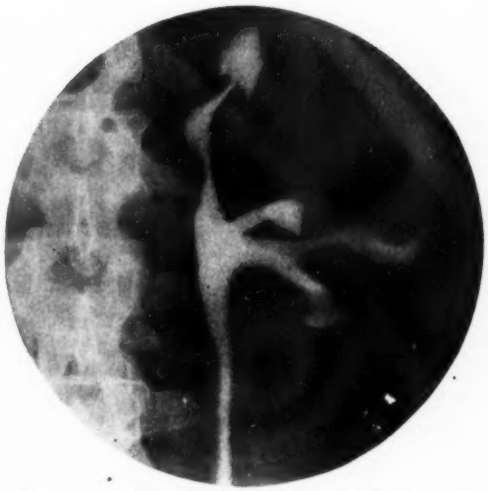


Fig. 16. Spider-leg deformity characteristic of hypernephroma.

RENAL TUMOR

Tumors of the kidney affecting the outline of the pelvis are neoplasm, polycystic kidney, solitary cyst, and echinococcus cyst.

Neoplasm. Neoplasms usually produce the greatest degree of pelvic deformity, and are manifested by: (1) elongation of one or more of the calyces or the true pelvis; (2) encroachment of the pelvic lumen causing (a) flattening of the general pelvic outline, (b) narrowing of the individual calyces, (c) obliteration of the true pelvis, (d) obliteration of one or more of the calyces, and (e) complete occlusion at or near the ureteropelvic juncture; (3) abnormal position of the renal pelvis; (4) secondary pyelectasis, and (5) deformity at the ureteropelvic juncture.

Probably the earliest deformity of the pelvis resulting from renal tumor is characterized by the elongation of one or more calyces. As the tumor enlarges toward the periphery it draws out the calyx with it. When the tumor is confined to either pole of the kidney elongation may be confined to the adjacent calyx. The number of calyces involved, as well as the extent of elongation, increases with the size of the tumor. With elongation of multiple calyces, the larger portion of the kidney is usually involved. The calyces may be stretched out to unusual lengths, sometimes as far as 10 or 12 centimeters, producing a deformity in the pyelogram, which might well be designated as a "spider-leg" deformity. This type of deformity is most common with hypernephroma. The so-called alveolar carcinoma produces greater deformity of the pelvis than that caused by hypernephroma (papillary carcinoma), and there is a greater tendency to involvement of the calyces. If the pelvic deformity is marked and the symptoms of short duration, the possibility of alveolar carcinoma should be considered. Hypernephromata may involve the renal parenchyma so completely as to occlude the lumen of the pelvis and calyces. When this occurs, the medium is usually obstructed at or near the pelvic juncture.

Figure 16 shows the spider-leg deformity characteristic of hypernephroma. Figure 17 is a bizarre type of pyelogram showing marked irregularity of the upper ureter and pelvis with obliteration of the upper and lower major calyces. The general appearance is suggestive of renal tumor. At operation a fibrosarcoma of the kidney was found. Figure 18 shows the absence of the upper major calyx together with a marked filling defect of the pelvis. There is evidence of beginning elongation of the middle calyx. At operation an alveolar

Fig. 17. Marked irregularity of upper ureter and pelvis with obliteration of the upper and lower major calyces. At operation a fibrosarcoma of the kidney was found.

carcinoma of the kidney was removed. The pyelogram illustrates the type of deformity which usually occurs as a result of alveolar carcinoma.

When a tumor involves the pelvis to a considerable extent, it may also encroach on the adjacent portion of the ureter. As with primary tumors of the pelvis, such involvement may cause either distention of the walls or obliteration of the lumen.

When the tumor originates in the pelvis it will either occlude its lumen or cause pyelectasis. Primary intrapelvic tumors are usually papillomatous; in order of frequency they are: papillary epithelioma, benign papilloma, inflammatory granuloma, and angioma. As would be expected, greater deformity is usually found in the true pelvis than in the calyces. If the papillary growth is extensive, the pelvic lumen may be largely obliterated, causing an irregularly contracted outline in the pyelogram. Bizarre pyelographic deformities occasionally result from tumors of the pelvis, but they rarely show the elongation and obliteration of the calyces such as occurs with tumors originating in the substance of the kidney. With a history of hæmaturia and demonstrable pyelectasis in the pyelogram the possibility of papillary epithelioma of the renal pelvis should be considered.

The most common of neoplastic growths in the ureter is the papillary epithelioma, and it usually occurs secondary to involvement of the renal pelvis. Therefore any unusual deformity in the outline of the ureter suggesting neoplasm should suggest the possibility of a papillary epithelioma.

Figure 19 illustrates a deformity of the left renal pelvis and marked dilatation of the calyces. The irregular moth-eaten outline of the pelvis with apparent obstructive dilatation suggested papillary epithelioma; the condition was verified at operation.

Benign tumors of the kidney are rare and present no unusual characteristic in the pyelogram which would differentiate them from other forms of neoplasm. The spider-leg deformity so frequently seen with hypernephroma is rarely if ever seen with benign tumors. The pyelogram is more likely to resemble that of true renal carcinoma; in such a case there is more likely to be deformity of the pelvis, and obliteration and abbreviation of the calyces.

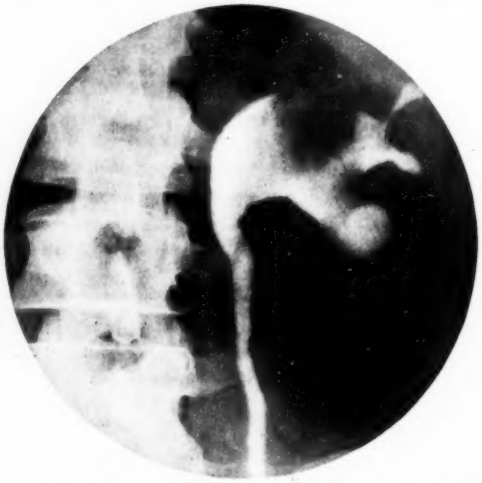


Fig. 18. Abscence of upper major calyx, marked filling defect of pelvis, and beginning elongation of middle calyx. At operation alveolar carcinoma of the kidney was found

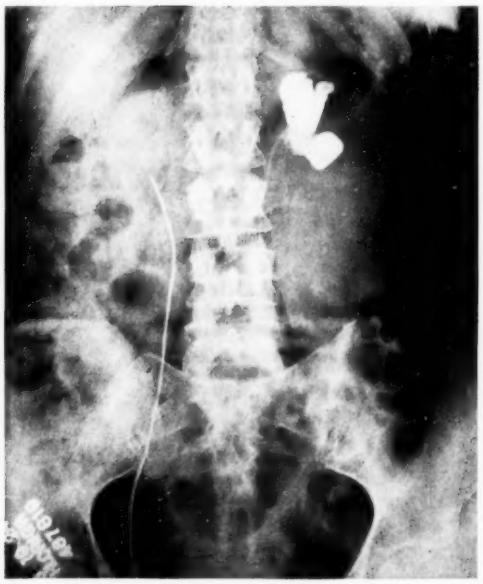


Fig. 19. Deformity of left renal pelvis with marked dilatation of calyces. The irregular moth-eaten outline of pelvis with apparent obstructive dilatation is suggestive of papillary epithelioma. This was verified at operation.

Fig. 20. Upper displacement of lower major calyx and pelvis with irregular outline of pelvis and calyces. A soft shadow is cast by the tumor. At operation simple adenoma of the kidney was found.

The benign types of tumor, even though rare, which must be considered in a differential diagnosis of renal neoplasm are adenoma, cystadenoma, and lipoma.

Figure 20 is a pyelogram of the right kidney in which there is upward displacement of the lower major calyx and pelvis. This irregular outline and the globoid outline of the substance of the kidney suggest a tumor of the lower pole. At operation a simple adenoma of the kidney was found.

Polycystic kidney. Abnormality in the pelvic outline accompanying polycystic kidney will not be apparent in the pyelogram as consistently as with renal neoplasm. The changes in the outline of the renal pelvis which may occur with polycystic kidney are as follows: (1) shortening or obliteration of one or more of the calyces, giving the pelvic outline an oval or irregularly squared contour; (2) compression of one or more calyces by cysts, causing them to assume a circular or semicircular outline; (3) broad irregular extension of the calyces; (4) partial obliteration of the pelvis as a result of extension or compression of the cyst; (5) change in position and axis of the pelvis, and (6) inflammatory changes consequent to secondary infection.

Figure 21 illustrates the usual type of deformity seen with polycystic kidney. There is but little deformity of the pelvis, which is incompletely filled, while the calyces are elongated and unusually dilated. Since the polycystic condition is the result of congenital renal defect, bilateral pelvic abnormality is always demonstrable. When the nature of the deformity is doubtful it is advisable to make a pyelogram of the other kidney.

Solitary cyst. A large solitary cyst may often be symptomless. The urinary cystoscopic data may be negative and the nature of the tumor will remain unrecognized. When the cyst becomes so large, or is so situated, as to compress the pelvis, the resulting deformity may be outlined in the pyelogram as follows: (1) abbreviation of the adjacent calyces; (2) compression and flattening of the adjacent portion of the renal pelvis, and (3)

Fig. 21. Usual type of deformity seen with polycystic kidney; pyelogram showing incomplete filling.

change in position and axis of the kidney as the result of increased weight in one pole. Occasionally it may be difficult to differentiate the condition from neoplasm or polycystic growth, and the shadow may be confused with that caused by pressure from extrarenal tumor. A normal pyelogram would not necessarily exclude a cyst, since occasionally it may be situated so as not to deform the renal pelvis.

Figure 22 is a pyelogram of the right kidney in which there is upward displacement of the pelvis and calyces with medial displacement of the ureter. The outline of the renal substance can be distinctly seen. The pelvis and calyces are dilated as a result of mechanical obstruction. At operation a cyst of the lower pole of the kidney was found.

Hydatid disease of the kidney is not common, and depends on the history of the case and cystoscopic data other than pyelographic for diagnosis. There is nothing characteristic or pathognomonic in the pyelogram; the deformities are similar to those caused by single and polycystic kidneys.

Extrarenal tumor. While a roentgenographic shadow of extrarenal tumor in its relation to a shadow of the kidney may often be of value in identifying an extrarenal tumor, it cannot always be relied on, since the outline of the tumor may be obscurely merged with a more or less indefinite renal shadow. If, however, a normal renal pelvis is demonstrated in the pyelogram at some distance from, or in impossible relationship to, an adjacent tumor shadow, its nature may be definitely assumed. However, pressure from the extrarenal tumor may cause displacement of the pelvic outline similar to that with renal neoplasm, although it is usually more moderate. Retroperitoneal tumor will probably cause the greatest change in position. As a result of pressure the pelvis and calyces may become elongated or constricted so as to simulate deformity caused by renal tumor.

Source of error in the interpretation of the pyelogram. The many difficulties that may arise to prevent obtaining successful pyelograms in such cases are: (1) errors resulting from faulty pyelographic technique; (2) obstruction to the ureteral catheter; (3) inability sufficiently to distend the pelvis of the kidney and ureter because of immediate return of fluid; (4) dilution of the injected fluid by retained fluid in the pelvis; (5) obscuring of the pelvic outline by the overlying tumors;

Fig. 22. Displacement of pelvis and calyces with medial displacement of ureter. At operation a cyst of the lower pole of the kidney was found.

(6) deformity too slight to be recognized, and (7) error in interpretation.

Practically every tumor involving more than one-third of the kidney will have recognizable deformity; if it is confined to either pole of the kidney it may not cause enough deformity to be of diagnostic value. On the other hand, a comparatively small tumor, when situated adjacent to the pelvis, may cause marked deformity.

Occasionally a coagulated blood clot in the pelvis or upper ureter may cause a filling defect which closely resembles tumor. An extensive clot may almost obliterate the pelvic lumen, leaving irregular streaks adjacent to the pelvic walls, or crevices within the clot area. Clot deformity can be very confusing and has frequently been mistaken for that of neoplasm. In doubtful cases it is well to repeat the pyelogram several days after the hæmaturia has ceased.

Congenital conditions, such as renal torsion and pelvic or fused kidney, may be the cause of evident abdominal tumors best identified by means of pyelography. If a tumor can be demonstrated in the pyelogram, when palpation is of doubtful value, diagnosis is certain. A normal pelvic outline, to a great extent, excludes renal involvement.

Pyelography is of considerable value in determining the cause of renal hæmaturia. In the differential diagnosis of obscure neoplasm and chronic infection with hæmaturia or the so-called essential hæmaturia, pyelography may be the only clinical method available. The demonstration of a normal pelvis in a case of hæmaturia is of definite value in the identification of so-called essential hæmaturia. Urography is particularly useful in the identification of abdominal tumors when the previous history of hæmaturia has been indefinite or uncertain and when an examination of the urine is negative or demonstrates but few microscopic elements.

It may be difficult to determine clinically the exact nature of a closed renal tumor. The three most common forms, for example, tuberculous process, neoplasm, and hydronephrosis, may occasionally be difficult to differentiate by cystoscopic examination, and urography may be necessary.

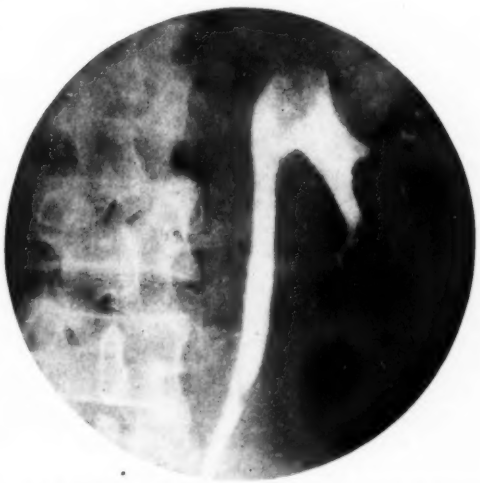


Fig. 23. Filling defect in pelvis, with absence of upper major calyx and beginning elongation of the calyces. At operation a hypernephroma with multiple cysts was removed.

Figure 23 illustrates distinctly a filling defect in the left pelvis. Similar filling defects are occasionally produced by blood clot. Because of the absence of the upper major calyx, and beginning elongation of the calyces, in this case a diagnosis of renal neoplasm was made. At operation a hypernephroma with multiple cysts was removed.

Figure 24 is an original roentgenogram which shows a diffuse mottled shadow in the region of the left kidney. Figure 25 is a urogram of the same case. There was obstruction to the catheter and to the outflow of medium just below the usual position of the ureteropelvic juncture, demonstrating an occluded left kidney. At operation a large hypernephroma was removed.

LITHIASIS

The nature and identification of shadows in the region of the kidney are greatly facilitated by means of pyelography. The pyelogram makes it possible to differentiate urinary and extra-urinary shadows; if intra-urinary their exact situation can be determined. Although most of the shadows in the kidney may be identified by their contour, character, and position, yet the shadow of renal stone is fre-

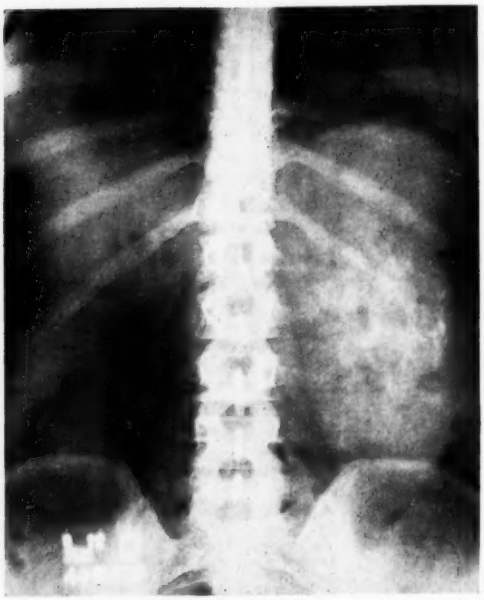


Fig. 24 (left). Original roentgenogram showing diffuse mottled shadow in region of left kidney.

Fig. 25 (right). Same case as in Figure 24. Obstruction to catheter and medium just below the usual position of the ureteropelvic juncture, demonstrating an occluded left kidney. At operation a large hypernephroma was removed.

quently atypical in these respects and may be easily confused with extrarenal shadows.

In the course of the routine roentgenographic examination, shadows may be encountered that are suggestive of renal stone and yet the clinical data, either subjective or objective, would negate its existence. Corroborative data, other than those derived from the ordinary roentgenogram, will frequently be necessary. In such cases the information obtained by means of cystoscopic inspection and the ureteral catheter are sufficient. In other cases shadows can be identified only by means of pyelography. This method should not be employed, however, as a routine procedure, but used only when interpretation is doubtful. The pyelographic data which will make it possible to determine whether a shadow is intrarenal or extrarenal are: (1) the distance separating the shadows from the pelvic outline; (2) the exact relationship of the shadow to the pelvic outline, and (3) the presence of pathological changes in the pelvic outline. When the distance separating the shadows in question is more than 4 centimeters the shadow will be demonstrated as extrarenal.

Changes in the pelvic outline by stone occasionally show a greater distention of the individual calyces than that of the true pelvis. Occasionally the dilatation will predominate in the true pelvis with comparatively little deformity of the calyces, and is then usually the result of obstruction rather than inflammation. The degree of deformity in the pelvic outline is not dependent on the size of the stone. Frequently a comparatively small stone will be accompanied by considerable deformity. Again, surprisingly little deformity accompanies a stone which fills practically the entire pelvis.

Figure 26 shows a shadow in the region of the left kidney. Figure 27 shows the inclusion of the original shadow with slight dilatation of the pelvis and a spasm at the ureteropelvic juncture frequently seen with stone in the pelvis. This is probably a result of mechanical irritation. Figure 28 shows a shadow in the region of the left kidney. Figure 29 shows

Fig. 26. Shadow in region of left kidney.

Fig. 27. Inclusion of original shadow with slight dilatation of pelvis and a spasm at the ureteropelvic juncture. This is probably a result of mechanical irritation.

the original shadow apparently included in the outline of the pelvis and calyces. Because of the patient's history, it was believed that additional data were necessary in order to make a diagnosis of renal calculus. Figure 30 is a roentgenogram of a lateral view and shows the original shadow in front of the second

Fig. 28. Showing a shadow in the region of the left kidney.

Fig. 29. Same case as in Figure 28. Original shadow apparently included in outline of pelvis and calyces.

Fig. 30. Same case as in Figures 28 and 29. A roentgenogram made in a lateral position, showing the original shadow in front of the second lumbar vertebra, an example of the value of lateral views.

Fig. 31. Same case as in Figures 28, 29, and 30. Pyelogram made in the lateral position showing the inclusion of the original shadow. Stone was removed from the pelvis of the kidney.

lumbar vertebra. Figure 31 is a pyelogram made in the same position and shows the inclusion of the original shadow in the outline of the pelvis. At operation a stone was removed from the pelvis of the kidney. This illustrates the value of lateral views, as well as anteroposterior, in the diagnosis of questionable shadows.

Fig. 32. Filling defect in outline of pelvis and calyces caused by a soft stone which was permeable to the roentgen ray.

If stone has remained in the kidney for several years and there is secondary pyelonephritis, extensive cicatricial atrophy of the renal parenchyma may result. The pelvis may show marked cicatricial changes, and become irregular and small as a result. In some cases the pelvis is also infiltrated and constricted by peripelvic inflammatory fat.

Cortical stone. True cortical stones are so rare that their existence may be regarded as doubtful. Stones occurring in the renal parenchyma may be of two varieties, those which result from calcium deposition as in renal tuberculosis, or hypernephroma, and pyogenic abscesses which have undergone resolution with calcification; these may be regarded as true cortical stones. The pseudocortical stones are those frequently seen just distal to the minor calyces. These areas of calcification have their origin in the tips of the minor calyces and through a process of inflammatory reaction they become walled off and encysted, and in time become separated from the remainder of the calyx by scar tissue. This variety of cortical stone is often seen in routine pyelography and is more apt to be multiple.

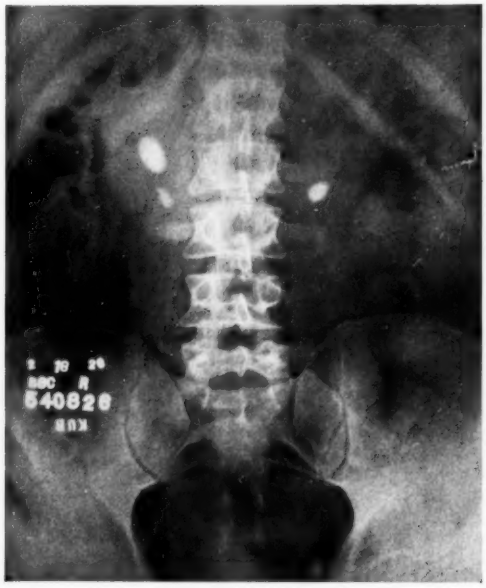


Fig. 33. Multiple shadows in region of left and right kidneys. The shadows are unusually near the vertebral column; and both renal outlines tend to fuse in the lower half.

Fig. 34. Same case as in Figure 33. Left pyelogram showing inclusion of original shadow in the outline of the left half of a horseshoe kidney.

Absence of stone shadow. Not all renal stones cast shadows. It was formerly believed that the intensity of the shadow depended on the density of the stones and the quality of their composition. As a rule stones composed largely of calcium oxalate cast the most dense shadows, and those composed largely of sodium phosphates shadows of less density. Stones arising from a decomposition of protein material, such as cystin from the sulphur-containing compounds, and xanthin and uric acid from the purin bases, may or may not cast shadows. Imperfect roentgenographic technique and failure properly to prepare patients are factors which make it impossible to detect renal stone in the roentgenogram.

Figure 32 shows a filling defect in the outline of the pelvis and calyces, caused by a soft stone which was permeable to the roentgen ray.

CONGENITAL ANOMALY

The clinical diagnosis of congenital anomaly of the kidney and ureter was first rendered possible by the introduction of the shadow-casting ureteral catheter. The relative position of the two renal pelves, the course of the ureter, and the duplication of the ureter and pelvis was often shown. With the development of pyelography, additional and more accurate data have been acquired in the exact diagnosis of congenital anomaly. By its means we are able to ascertain the existence of congenital anomalies and the existence and nature of pathological conditions which may complicate them.

In previous publications one of us (Braasch) has called attention to the frequency with which pathological conditions are encountered in congenital malformation of the urinary tract, particularly the renal anomalies. Changes incident to obstruction, such as hydronephrosis, infection, and lithiasis, are the most common.

Figure 33 illustrates multiple shadows in the region of the right and left kidneys. On close inspection it will be noted that the shadows are unusually near the vertebral column and that both renal outlines tend to fuse in

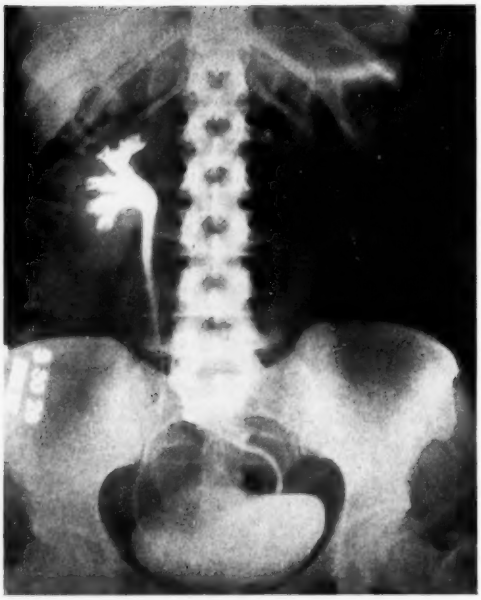


Fig. 35. Bilateral pyelogram with left ectopic kidney.

the lower half. Figure 34 is a pyelogram of the left kidney showing the inclusion of the original shadow in the outline of the left half of a horseshoe kidney. The anomalies in the kidney and ureter which may be demonstrated by means of pyelo-ureterography are: duplication of the renal pelvis, duplication of the ureter, fused or horseshoe kidney, congenital increase or decrease in the size of the pelvis, renal torsion, and ectopic kidney.

Duplication of the renal pelvis. Duplication of the renal pelvis may be partial or complete and may vary in degree from the abnormal elongation of the upper calyx to two distinct and widely separate pelves, and occasionally triplication of the pelves occurs. With complete pelvic duplication, the ureters may unite at different levels below the ureteropelvic juncture. The disparity in size of the two pelves occurs so frequently that if, in the course of routine pyelography, the outline of the pelvis is unusually small and high-lying, duplication of the pelvis should be inferred and attempts made to outline the lower pelvis. It is important to determine the amount of tissue which separates the two pelves when one of them is diseased. If a considerable distance separates the two pelves surgical bisection is less difficult; when the two pelves are in such close proximity that the calyces overlap, bisection is more difficult.

Duplication of the ureter. Duplication of the ureter may be complete or partial, bilateral or unilateral. Often with complete duplication the course of the ureters crosses twice before entering the bladder. While this is a frequent observation, complete duplication of the pelvis and ureters may occur without evidence of ureteral crossing at any point throughout the course of the ureter. When crossing does occur it is usually at a short distance below the ureteropelvic juncture, and again at a short distance above the wall of the bladder. The ureter leading from the lateral and posterior meatus will be found to lead into the lower of the two renal pelves, whereas the ureter leading from the medial and anterior meatus will be found to lead into the upper of the two renal pelves. The two ureters are usually separate and are situated a variable distance apart throughout their course. Occasionally, however, they lie in close apposition, surrounded by a common fibrous sheath. In rare instances such closely approximated ureters may be bound together at certain points. The exact relationship of the two ureters can be demonstrated by means of the ureterogram.

Fused kidney. Although the relative position of the two divisions of a fused kidney can be determined by means of the shadow-casting catheter, nevertheless more accurate localizing data can usually be obtained by means of the pyelogram. The two pelves do not as a rule lie symmetrically with respect to the vertebral column. The most common situation is that in which the lower pelvis is visible near the median line and the upper pelvis is distinctly lateral and more nearly normal. Occasionally the relative position of the two pelves in a fused kidney may become confused with the position of a median-lying ectopic kidney and a moderate low-lying kidney. As a rule, however, peculiarities in position and character of the low-lying pelvis, as well as its ureter, will identify the condition. As with unilateral duplication of the pelvis, the upper

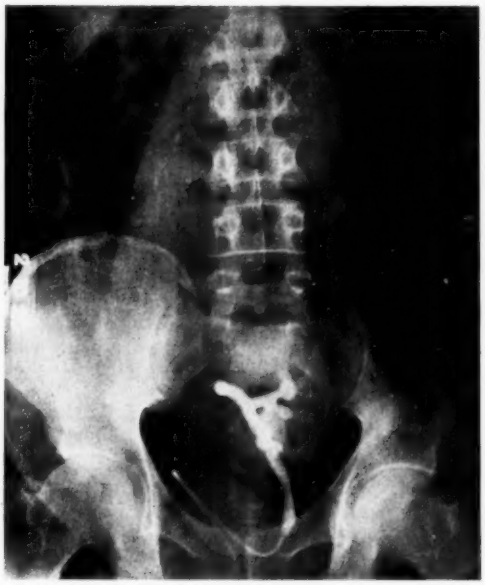


Fig. 36. Left ectopic kidney.

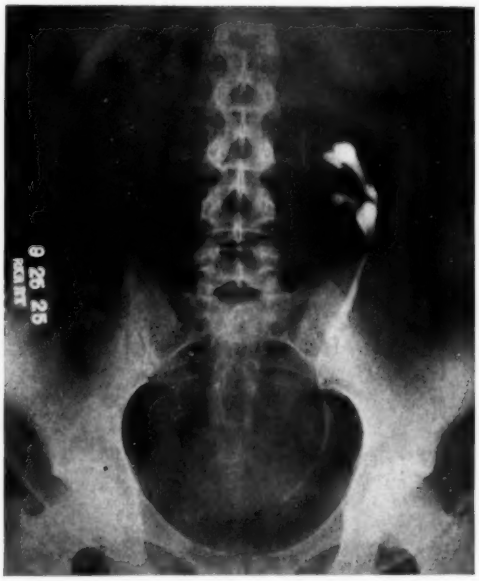


Fig. 37. Left ectopic kidney.

pelvis of a fused kidney is usually distinctly smaller than the lower pelvis. In a unilateral pyelogram the possibility of a fused or horseshoe kidney should be considered if the ureter leaves the pelvis in a lateral direction instead of the normal median direction.

Congenital increase or decrease in size of pelvis. With a congenital solitary or asymmetric kidney the increase in size and capacity of the pelvis is usually commensurate with that of the kidney. If one kidney becomes larger because the other is destroyed the size of the pelvis does not as a rule increase to a relative extent.

Occasionally, in the course of routine pyelography, we are astonished to find an unusually large pelvis in patients who have little or no objective symptoms suggestive of renal lesion and in whom we have no other pathological data indicative of mechanical obstruction in the ureter. The enlargement is usually bilateral and is characterized by marked elongation of the true pelvis. The calyces are well formed, but are exceptionally broad at the base. The apices and minor calyces appear normal in contradistinction to the marked change which usually occurs with pelvic enlargement of hydronephrosis. This condition should not be confused with dilatation of the pelvis and ureter, which is congenital and has been called congenital atony of the renal pelvis. The latter condition is differentiated by an accompanying dilatation of the ureter throughout its extent, which does not occur with a congenital large pelvis. Further, with congenital atony the outline of the renal pelvis is typical of hydronephrosis.

Congenital decrease in the size of the pelvis occurs with congenital atrophy of the kidney. This condition, while rare, is occasionally seen and should be remembered when evidence of hypertrophy is apparent in the opposite kidney. As a rule the diminished secretion and evidence of atrophy in the meatus and ureter will call one's attention to the diminished function. In the pyelogram the pelvic outline appears small, and the calyces, while rudimentary, show no evidence of inflammatory change.

Renal torsion. Although the direction of the calyces with movable kidney may be unusual because of partial rotation of the kidney, the

complete reversal of the normal direction of the calyces and of ureteral insertion rarely complicates the ordinary movable kidney. With renal torsion, the outline of the pelvis and calyces is reversed. Instead of the calyces extending in a general lateral direction they extend toward the vertebræ. The ureter, instead of leading toward and parallel to the vertebræ, now leaves the pelvis at the usual situation of the lateral border. The position of the kidney may cause it to be unusually prominent on abdominal palpation, and it may easily be confused with tumor. Unless the position of the other kidney is ascertained by means of a pyelogram this condition may be confused with a horseshoe kidney, which sometimes has a similar arrangement of calyces and ureter.

Ectopic or pelvic kidney. Moderate deviation from the normal position, or even a freely movable kidney, is not necessarily a congenital anomaly. When, however, the kidney is found lying fixed in the bony pelvis, and when its blood supply comes from the adjacent arteries, it must be regarded as a true congenital anomaly. Although the relative position of a pelvic kidney can frequently be ascertained by means of the shadow-casting catheter, the possibility of error when the opaque catheter is otherwise obstructed must always be considered. The position of the kidney and its relation to the ureter, as well as any pathological complication which may be present, can be definitely ascertained by means of the pyelogram. It may be difficult to distinguish between the low-lying pelvis of a fused kidney and a pelvic kidney. As a rule the distance between the pelvis of an ectopic kidney and the pelvis of the normally situated kidney would be much greater than that separating the two pelves of a fused kidney. Lateral or posterior insertion of the ureters into the pelvis would aid in differentiating the two conditions. The ectopic kidney may be felt as a suprapubic tumor, and it is in the identification of this tumor that the pyelogram may disclose the condition.

Figure 35 is a bilateral pyelogram with a transposed left ectopic kidney. Figure 36 shows a left ectopic kidney. Figure 37 shows a low-lying kidney with complete torsion suggesting congenital anomaly. A pyelogram of the right side was normal. At operation a left ectopic kidney with a long pedicle was found; the pedicle permitted considerable excursion, which probably accounts for the apparently high position of the kidney, as the majority of ectopic kidneys are within the bony pelvis.

TENDON TRANSPLANTATION[1]

By FRITZ LANGE, M.D., Munich, Germany
Professor Ordinarius of Orthopedics, University of Munich; Director of the Royal Bavarian Orthopedic Clinic of Munich

THE idea of restoring the lost function of a muscle by transplanting tendons originated with the noted surgeon Nicoladoni. It consists in utilizing the strength of a neighboring sound muscle by carrying it across to the paralyzed muscle and suturing the two tendons together. Unfortunately Nicoladoni's operation did not prove altogether a success.

When in the year 1896 I performed the first tendon transplantation operation, I found only too soon that I was unable to prevent the recurrence of a deformity by placing the limb in plaster of Paris for several weeks after the operation. Similar experiences were also reported by other surgeons and we had to agree that even prolonged plaster-of-Paris dressing should be followed by additional after-treatment with other fixation methods. This seemed to be essential if a perhaps permanent success was to be achieved.

However, even after the most careful after-treatment, we still experienced misfortunes. Upon removal of the plaster of Paris, we often noticed that, although the transplanted muscle showed distinct function, the function disappeared again in a few weeks. The cause was proved to be that the paralyzed end of the tendon had stretched. Particularly was this true when we were dealing with short tendons such as those of the quadriceps, gluteus, or deltoid muscles. If one of the latter was paralyzed and the tendon in a morbid state, it was clear that by suturing a sound muscle to the paralyzed tendon, no security could be attained.

Acting upon my experiences I advised that Nicoladoni's operation (tendon upon tendon) be replaced by the periosteal method of tendon transplantation. Figures 1 and 2 demonstrate the differences between the two operations.

Suppose, for example, we are faced with the necessity of restoring the paralyzed tibialis anticus by means of the extensor hallucis. By Nicoladoni's method the active extensor hallucis would be divided about 5 to 8 centimeters above the ankle joint and the extensor united with the paralyzed tendon of the anterior tibial muscle (Fig. 1). By this method one part of the paralyzed tendon is utilized and expected to functionate in its union.

When the end of the paralyzed tendon is thin and easily yielding, it will prove especially disappointing to find that this tendon has stretched after the transplanted sound muscle has acted for some time in its capacity of pulling. On the other hand if the extensor hallucis is divided on the dorsum of the foot and the end sutured to the navicular bone, we would have the advantage that the transplanted muscle would consist entirely of sound and resistant tissue (Fig. 2).

Although we found that the periosteal method increased the number of positive successes, it could not be applied in all cases; sometimes it happened that the strength-giving muscle was so short that it could not be sutured to the periosteum.

The problem of inventing a method for satisfactorily lengthening short tendons was solved by the employment of improved technique and by the use of silk sinews. The first attempts in this direction were made by Gluck in the year 1882, who used for this purpose silk catgut. But faulty healing of the tissue around the silk made Gluck's operation impracticable.

After much effort we have managed to evolve a method, in which we also use silk, by which we have obtained considerable success and have been fortunate in eliminating post-operative abscesses even in cases in which we have embedded from 10 to 15 centimeters of stout silk. The number of failures was comparatively small. Among the first 850 cases which my assistant Dr. Graetz has reported, in only 3 per cent did the tissue fail entirely to heal.

[1] Address of welcome to American colleagues visiting Munich, June 5, 1926.

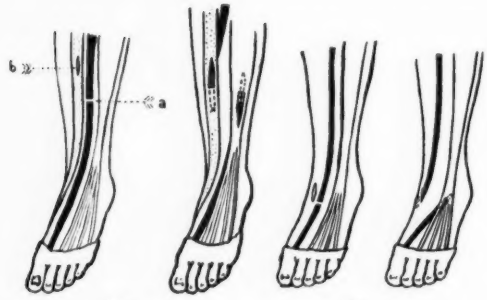


Fig. 1 Fig. 2

Fig. 1. Nicoladoni's operation.
Fig. 2. Periosteal tendon transplantation (Lange).

GENERAL TECHNIQUE

I personally use a silk sinew made out of 4 or 8 threads of Turner silk No. 6 or No. 12, sterilize the silk for 15 minutes immediately before the operation in a solution of oxycyanide of mercury, and draw the silk cord in a simple manner through the marginal line of tendon and muscle tissue. (See Figure 3.)

I am finding it very important to demand that all dressing be free not only from bacteria but also from spores. As a safeguard in this respect we always examine our dressing drums with the phenanthren tubes of Lautenschlager.

Furthermore, it is important to make sure that the silk strands are not placed in the immediate region of the skin incision, as suppuration of the sutures would naturally endanger the sterility of the silk. For that reason we prefer to make circular or lath-like incisions and secure the wound with several layers of subcutaneous stitches.

Certainly the silk sinew would show wear or even rub through in time if we could not rely on the silk being surrounded and protected by something. I am referring to the development of tendinous tissue around the silk—a remarkable example of what the human body can create when a foreign element is introduced and subjected to the influence of function. A silk sinew which is not active would build up no more surrounding tissue than a silk thread which has been used as a ligature for a vessel. On the other hand, a silk sinew which is always subjected to the contraction of a muscle belly, surrounds itself

Fig. 3. Method of drawing silk sinew through marginal line of tendon and muscle tissue.

with a thin coat of tendinous tissue, which is similar in nature to a real tendon from a mechanical point of view. (Figs. 4 and 5.)

Prior to the introduction of the use of parchment in our operative technique, I recognized that the problem of tendon transplantation had not been solved altogether. Certainly success was achieved in a great many cases, but on the other hand failures were also occurring, which fact prevented us from calling it a sure operation.

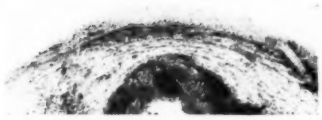
Thorough investigations at secondary operations proved that the cause of most failures was adhesions which had developed between the transplanted sinew and an immobile tissue (bone or fascia). The adhesions thus permitted interference with the muscle tension upon the peripheral part of the joint.

The problem of overcoming this difficulty is easier when we are dealing with fat patients and are able to carry the transplanted sinew through the adipose tissue, where the sinew readily adheres to and becomes a part of the adipose tissue. The activity of the sinew is not handicapped because the mobile fat cushion is present. I recommended this method at the Congress of Surgeons in Paris and reported for the first time my experiences with the troublesome adhesions after tendon transplantation.

Our new method gave us excellent results in patients with considerable adipose tissue. But this did not apply to our paralyzed patients who possessed only a negligible panniculus adiposus.

We were faced therefore, with the necessity of adapting the method to lean persons.

Biesalski hoped to overcome the difficulty by drawing the transplanted sinew through a sheath of tendon or through an overturned flap of fascia. I am afraid the scope of this method is but small.



T. *S.* *S.*

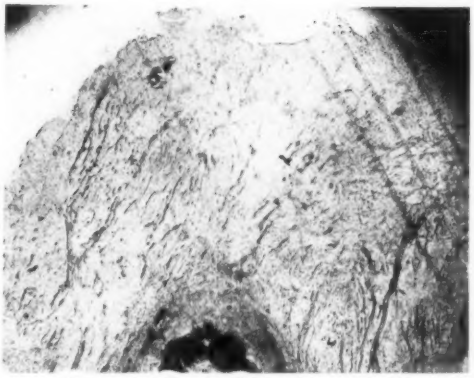
Fig. 4. A silk sinew which has been embedded and retained for a period of 8 years. This was not a success because the silk adhered to the bone and only a thin coat of connective tissue developed. *T.*, Tendinous tissue; *S.*, silk.

I then determined to perfect a technique which could be applied to any case. My first experiments were made with an autoplastic material, loose flaps of fat or fascia being used. But as, contrary to my expectations, these flaps developed and grew again into a firm mass, I was forced to try alloplastic material. Experiments upon animals showed that material such as we use in our paper bandages would prevent these annoying adhesions. I found that I could safely graft a 10 to 20 square centimeter piece of paper bandage into a body and that it would almost always heal up without complications. In the first hundred paper grafts I saw the graft expelled in only 2 per cent of the cases.

Connective tissue formed around the paper and developed into a sack. In time the latter contained paper pulp and fluid with numerous cells and acted entirely as a mucous bursa from a mechanical point of view. A mucous bursa is undoubtedly one of the most remarkable possessions of a human body. It is there to enable and to facilitate a tendon in doing oscillating movements in places where otherwise a rough passage would be met.

Unfortunately the paper material has a disadvantage; it is thin, delicate, and easily broken. For hard usage such as it would receive in an articular surface after surgical mobilization of any ankylosis, paper could not be recommended.

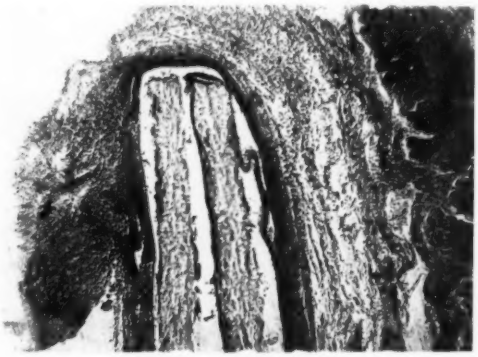
I felt extraordinarily well pleased with the work done by my senior assistant, Dr. Pitzen, and the results he obtained in his experiments upon animals. It showed that parchment was more suitable for our purpose, namely, the prevention of the development of adhesions. Parchment paper is very durable and strong; furthermore there is less risk of this paper being torn through a sudden



T. *S.* *S.*

Fig. 5. The silk sinew has been in the body for 12 years and has done its work. Thanks to the continuous movements of the sinew a thick coat of tendinous tissue has developed. *T.*, Tendinous tissue; *S.*, silk.

or violent movement of the body. Because of its strong properties we have accepted it as superior to the material of the paper bandages. Histologically there is also a vast difference between the parchment and the material used in the paper bandage. In parchment the dissolution in cells does not take place after it has been left in the body, as is the case with the paper; on the contrary, it remains intact and stimulates the development of a capsule consisting of a thin, loose, and mobile connective tissue. This capsule remains quite unattached to the



C. *P.* *P.* *C.* *T.* *T.*

Fig. 6. Prevention of adhesions through the introduction of parchment. C., Capsule; P., parchment; T., connecting tissue.

Fig. 7. Talipes calcaneus. Paralysis of the gastrocnemius. Both peronei and the posterior tibialis are secured to the tendo achillis. The calcaneus is secured as described in the text. A (left), before operation; B, after operation.

parchment and the parchment serves as a guard against the undesirable adhesions.

Parchment has given excellent results not only in tendon transplantation but also in tendon suture and as material to place between parts after surgical mobilization of an ankylosis. Furthermore we have been able to do away with the autoplastic material such as flaps of fat or fascia.

OPERATIONS ON THE FOOT

The object of tendon transplantation in the foot is to eliminate permanently deformities resulting from paralysis, and to enable the patient to walk without an apparatus. The deformity may be talipes equinus, talipes calcaneus, talipes varus, or talipes valgus.

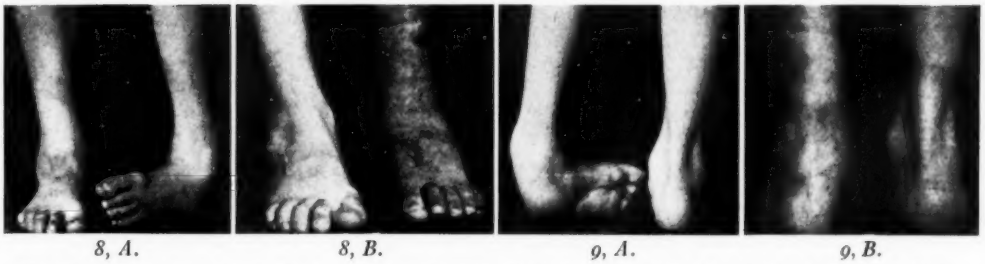
Prior to tendon transplantation it is always necessary to stretch the retracted tendons and ligaments of the deformed foot conservatively and to such an extent that one can reduce the displaced bones with ease. This is done in the vise which is adjusted to our operating table, a type of table which has served us excellently for over 30 years. Should the foot be very rigid, we prefer to place the foot in an exaggerated corrected position in plaster of Paris for a period of 2 weeks, after which time only the tendon transplantation is to be performed. If there is no rigidity, reduction is followed immediately by transplantation.

The most important part of tendon transplantation is the rearrangement of the balance of the muscle functions, which, I admit, is sometimes not an easy task, and if unsuccessful will result in a relapse; if, for instance, the newly constructed supinators of a paralytic talipes valgus are weaker than the pronators. On the other hand should we weaken the pronators too much we do so at the risk of having the correction overdone. We have had both results, but our experiences have taught us how to avert the danger and how to establish reliable and specific plans for the operations on the foot.

Talipes equinus. In talipes equinus the dorsal flexors, the tibialis anticus, and extensor digitorum are paralyzed. The posterior tibialis and the flexor muscles of the toes are also paralyzed. The long and short peronei are the only muscles which could act as substitutes for the dorsal flexors. We divide both peronei at the outside of the foot, extract them from the tendon sheaths, and carry them to the anterior surface of the leg. We stitch the end of the long peroneus periosteal to the navicular bone as a substitute for the tibialis anticus, and the peroneus brevis to the cuboid bone as a substitute for the extensor digitorum. This operation will enable the patient to bend his foot again freely dorsally and plantarly.

Talipes calcaneus. Talipes calcaneus (cavus) is entirely different from talipes equinus. Talipes calcaneus is caused by paralysis of the gastrocnemius. It is fortunate that the above paralysis affects no other muscles, especially fortunate, because it would only be possible to find a substitute for the solid gastrocnemius by sacrificing jointly all muscles which the patient could possibly do without, namely, the two peronei, the tibialis posticus, the flexor digitorum, and the flexor hallucis.

These muscles are divided as far below as possible and stitched to the tendo achillis. However, all these muscles together would not be strong enough to act as a substitute for a normal gastrocnemius, and it is essential, therefore, to guard the muscles carefully and not to allow them to stretch for a period of at least one year.



8, A. *8, B.* *9, A.* *9, B.*

Figs. 8 and 9. Talipes varus. Paralysis of the extensor digitorum. A silk sinew suspended from the anterior tibialis takes the place of the paralyzed extensor digitorum. A, before operation; B, after operation.

To avoid a relapse (the possible return to the position of a talipes calcaneus, we make it a practice when operating to extend a silk ligament from the tibia and fibula to the calcaneus and to secure the latter in the position of a talipes equinus. (Fig. 7 and A, B.)

Talipes varus. Tendon transplantation in paralytic talipes varus is comparatively easy. In the majority of these cases, a paralysis of the extensor digitorum and both peronei is present. Our task here is to establish new pronators which necessarily must be of equal strength to the supinators. Otherwise, the danger of relapse or exaggerated correction is great. A safe method is to fix silk sinews to the tibialis anticus and to the gastrocnemius. I generally secure a silk sinew to the tibialis anticus at its marginal line of muscle and tendon and carry the silk to the dorsum of the foot, following the course directed by the extensor digitorum; and stitch the silk to the cuboid bone. The result is even muscle tension of the tibialis anticus upon both sides of the foot.

It is a far more successful operation than that of splitting the tibialis anticus in halves and utilizing one-half for an external fixture. Certainly the strength of the anterior tibialis would suffer considerably from the latter operation. Apart from that, adhesions not only from the remaining tendon but also from the transplanted one might result and would certainly handicap the necessary oscillating movements of the tendons.

As a substitute for the paralyzed peronei, I carry a silk sinew from the middle of the gastrocnemius to the external edge of the calcaneus and stitch it there to the bone. This point of insertion serves as a special grip for the newly created pronator and has thus an advantage over the normal foot where only the pronator brevis, our most important pronator, has its point of insertion at the protuberance of the fifth metatarsal bone.

Because the inverted position of the calcaneus must be corrected in talipes varus, the benefit to be derived from the direct action of the silk sinew from the gastrocnemius upon the external edge of the calcaneus is very evident. (Fig. 8, A and B; Fig. 9, A and B.)

Talipes valgus. In dealing with talipes valgus, it will be our task to construct very powerful supinators in place of the paralyzed tibialis, as the equilibrium of the body has a tendency to force the foot back into the everted position. One achieves a permanent good result by weakening the pronators, especially the peronei. In this case the peroneus brevis suitably replaces the paralyzed tibialis anticus and can be transplanted anteriorly.

As a substitute for the paralyzed tibialis posticus we use as a rule a silk sinew which we suspend from the middle of the gastrocnemius in a way similar to that employed in dealing with talipes varus, and fix it to the median surface of the calcaneus. With this method we have succeeded in curing permanently the most outspoken types of talipes valgus. (Figs. 10 and 11.)

OPERATIONS ON THE LEG

Partial paralysis of the quadriceps. When dealing with a partial paralysis of the quadriceps we can use the tensor fasciæ and the sartorius. But it is not permissible to sever

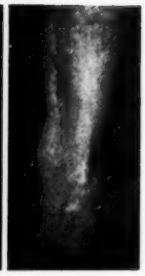
10, a.

Fig. 10, a and b. Before operation.

10, b.

11, a.

11, b.



11, c.

Fig. 11, a, b, c. After operation.

the two muscles completely for the purpose of transplanting both in front. Both are important tensor muscles for the external and internal knee ligaments; and by sacrificing both of the muscles a flail-like knee joint may very easily result. To avoid a lesion of the lateral knee ligament, we use the top half of the tensor fasciæ for the tendon transplantation, but leave the remaining half as a tensor of the joint capsule. A silk sinew suspended at the middle of the sartorius and bridged to the knee cap and to the tuberosity of the tibia assures knee extension.

Complete paralysis of the quadriceps. As a rule the tendon transplantations already mentioned are quite satisfactory in cases of partial paralysis of the quadriceps but in complete paralysis of the same muscle it is necessary to use at least the biceps or one of the half muscles. Under no consideration should we transplant all knee flexors to the extensor locality, for fear of getting a genu recurvatum.

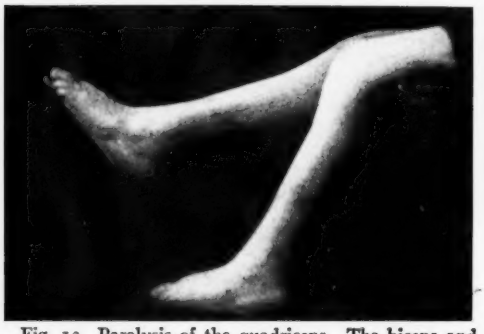


Fig. 12. Paralysis of the quadriceps. The biceps and the musculus semitendinosus have been used for the successful transplantation.

The success of a quadriceps plastic operation is dependent naturally upon the quality of the muscles serving as substitutes. It would be wrong to expect an entirely satisfactory substitute for the quadriceps from muscles affected by poliomyelitis or some similar condition. Still the patient experiences a vast improvement even though the leg can be extended only slightly. The majority of patients will be able to walk even without the apparatus, providing they have no pre-operative or postoperative loose (flail-like) knee joints.

OPERATIONS ON THE HIP

After my success with tendon transplantation on the knee and foot, I believed I could

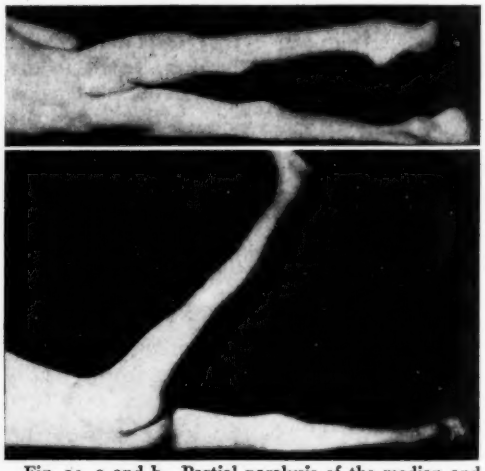
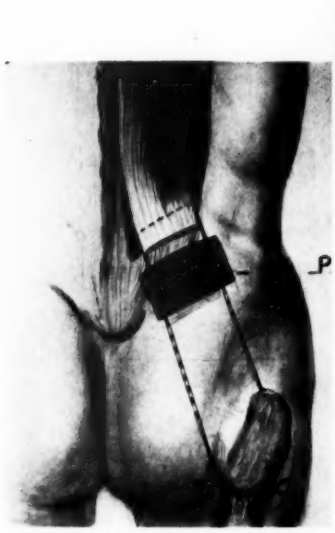


Fig. 13, a and b. Partial paralysis of the median and small glutei. a. The sound external vastus is used as a substitute.



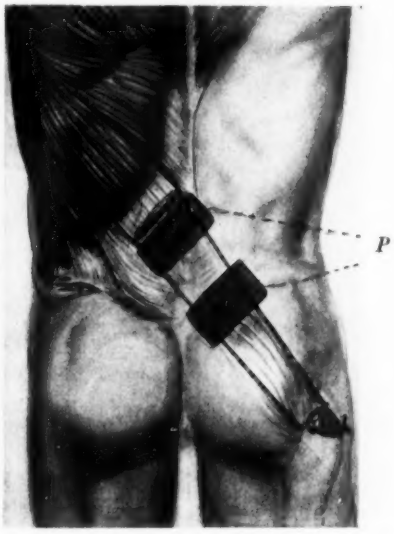


Fig. 14 (left). The erector spinæ transplanted to act as a substitute for the paralyzed gluteus. P., Parchment.

Fig. 15. A "long-distance" transplantation of the latissimus dorsi of the sound side to the femur of the paralyzed side.

expect similar results from a suitable substitute for the hip muscles. My first attempt in this respect was made about 20 years ago. I had to deal with the paralyzed median and small glutei. I separated the external vastus muscle at its proximal end, increased its length with a silk sinew, and stitched the silk to the iliac crest (Fig. 13).

This method gave good results when the external vastus was sound. But unfortunately experience has shown repeatedly that when the median and small gluteal muscles were paralyzed, the external vastus often was also paralyzed and this condition robbed us of the opportunity to use this muscle for the transplantation.

To overcome the difficulty, I decided therefore to make use of the erector spinæ as a substitute for the gluteal muscles. I believe I would never have performed this operation had it not been for the urgent request of a gentleman, the son of an American surgeon. He was suffering from an absolute paralysis of the gluteal muscles. This was the first case in which I attempted to substitute the erector spinæ for the gluteus maximus.

I exposed the distal end of the erector spinæ, split two-thirds of the muscle, lengthened the latter part with a silk sinew, and fixed the silk to the minor trochanter (Fig. 14).

I am pleased to say this first operation proved a complete success. Although I have not seen the patient for 2 years, his father wrote me stating that the hip joint had the full power of abduction and extension and that his son was now able to walk for about 3 miles without tiring. This particular operation has appeared in the American literature, described by Dr. Kreuscher. My method of operation was demonstrated to him on a corpse by the patient's father.

To provide a substitute for a paralyzed gluteus maximus is an operation of far-reaching significance. It is quite certain that the paralysis of the gluteal muscles is a greater handicap in walking than a paralysis of the quadriceps. I have never really succeeded in establishing a hip-extensor equal in quality and value to a gluteus maximus; but still, the patients have at least experienced an enormous improvement, thanks to the partial substitution of the gluteus maximus.

Fig. 16.

Fig. 17.

Fig. 18.

Fig. 16. Paralysis of the deltoid, biceps, and brachialis. Arthrodesis of the shoulder joint. The activity of the elbow is established with a silk sinew from the major pectoralis.

Figs. 17 and 18. Exhibiting very plainly the tension of the silk tendon leading from the pectoralis muscle to the forearm.

It enables the patients to enjoy a limited command and control over the leg, whereupon before the operation the leg was just suspended from the body and could have been thrown by the patient "to and fro" only with the movement of the body.

Following up the good results obtained with the erector spinæ as a substitute, I decided to go further and use the latissimus dorsi from the sound side of the patient as a substitute for the median and small glutei of the paralyzed side. The results were also most gratifying.

The method of the operation is plainly illustrated in Figure 15.

OPERATIONS ON THE ARM

The most common kinds of paralysis of the arm are (1) paralysis of the deltoid muscle with inability to lift the arm at the shoulder joint; and (2) paralysis of the biceps and the internal brachial muscle with inability to bend the forearm at the elbow. Although the muscles of the shoulder blade, triceps, hand and fingers are usually not affected, the arm is still useless.

An easily performed arthrodesis makes it possible to lift the upper arm at the shoulder joint. As a substitute for the biceps I use the major pectoralis, which can be spared because of the arthrodesis of the shoulder joint. I separate the pectoralis from the humerus lengthen this muscle with a silk sinew, and stitch the silk to the radius or ulna. (Figs. 17 and 18.)

CONCLUSIONS

By the introduction of the use of parchment into the already established method of using silk tendons, tendon transplantation has become a success with its consequent promise of new possibilities to our paralyzed patients. The operation is a great addition to orthopedic surgery in general and many surgeons will welcome the freedom from scheming after they have decided upon an operation in which muscle tension is to be established perhaps from a "fair distance."

I personally feel most gratified that the long and tedious work has not been in vain, for I am pleased to say that we are today counting ourselves successful in 90 per cent of our cases of tendon transplantation.

END-RESULTS OF CHOLECYSTOSTOMY AS SHOWN BY THE CHOLECYSTOGRAM

By ROY G. SPURLING, M.D., Louisville, Kentucky

AND

LESTER R. WHITAKER, M.D., Boston, Massachusetts

From the Surgical Service of the Peter Bent Brigham Hospital, and the Laboratory for Surgical Research, Harvard Medical School

DURING recent years the majority of surgeons have favored removal of the gall bladder when it becomes diseased. There are many, however, who still hold that the organ should not be removed when it can be spared, the operation of choice being drainage.

That the gall bladder is of use in the process of digestion has been fully demonstrated. Rous and McMaster (4) and others proved that it has marked power of concentrating the bile carried to it from the liver. It has also been shown that bile is stored in the gall bladder during the intervals of digestion, and emptied into the duodenum in response to the ingestion of proteins and fats (1, 2, 3, 5, 6, 7, 8). However, the excellent results obtained in thousands of patients upon whom cholecystectomy has been performed show that the gall bladder is not essential to health. Consequently, it would seem that the operation of choice would be cholecystectomy should there be any possibility of future trouble from leaving it in place.

Following a suggestion by Dr. Cushing we have recalled for purposes of examination a series of patients in whom the gall bladder had previously been drained and not excised, with the object of determining by cholecystography whether or not a pathological condition of the organ persisted. In some of these cases a second operation has been performed and a histological study made of the gall bladder, thus affording an accurate check upon the cholecystographic data. We have also endeavored by some laboratory experiments to obtain further evidence as to the significance of the cholecystographic findings in the patients who were not operated upon.

CLINICAL DATA

Cholecystograms by the intravenous injection of sodium tetra-iodophenolphthalein

Fig. 1, a.

Fig. 1, b.

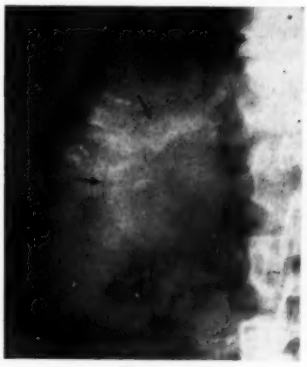


Fig. 2, a.

Fig. 1a. Cholecystogram at 12 hours of a patient with a normal gall bladder. The density of the shadow is about average for the intravenous method, indicating an active concentration by the mucous membrane.

Fig. 1b. Cholecystogram at 14 hours, one hour after a meal. A marked reduction in size of the shadow, indicates a normally contractile musculature of the gall bladder.

Fig. 2a. Cholecystogram at 12½ hours, made 25 days after the removal of stones from the gall bladder, and immediately after the closure of the drainage tract. The shadow is much larger and much fainter than normal by the intravenous method.

Fig. 2, b.

Fig. 3, a.

Fig. 3, b.

Fig. 2b. Cholecystogram at 15 hours, one hour after a meal. The shadow has increased only slightly in density, indicating an abnormal mucous membrane; it is, however, moderately reduced in size, which tends to show that the wall is fairly normal.

Fig. 3a. Cholecystogram at 10 hours of a patient from whose gall bladder numerous stones were removed 12 years previously, followed by drainage. There have been no symptoms. The density of the shadow is below normal for the intravenous method.

Fig. 3b. Cholecystogram at 13 hours, one hour after taking food. There is some increase in density of the shadow, but no contraction after eating. This indicates that the concentrating activity of the mucous membrane is fair but that the contractile power of the musculature is diminished, probably due to sclerosis.

were accordingly made on twelve patients whose gall bladders had previously been drained.[1] The data have been summarized in the accompanying table. The interval elapsing between the operation and the cholecystography varied from 25 days to 19 years.

None of the twelve patients had normal gall-bladder shadows. Four showed a recurrence of calculi as proved by a second operation; and two more showed markedly thickened, sclerotic gall bladders. The six remaining cases were not operated upon but the cholecystograms in all showed evidence of biliary disease as demonstrated either by a shadow abnormally faint or abnormally large (Fig. 2; compare with Fig. 1), or by the absence of contraction of the organ following the ingestion of food (Fig. 3).

EXPERIMENTAL DATA

It is difficult to reproduce in animals pathological conditions simulating those found in the human gall bladder, and thus to furnish controls for cholecystographic findings. Most observers agree that cholecystic disease, as we see it in the surgical clinic, has existed in many cases for years. However, some light may be thrown upon the problem by the effort to determine just what part of the pathological process is responsible for any alteration in the cholecystogram. Is this due to destruction of the mucous membrane, or to sclerosis of the walls of the organ with a disturbance of its lymph or blood supply?

In an attempt to answer this question the following experiments were performed: In five dogs the gall bladder was opened and thoroughly curetted. In two of these animals it was drained with a rubber catheter; in the other three it was closed after bleeding had been checked. In a sixth dog the entire mucous membrane was removed by blunt dissection and the gall bladder closed.

Starting 48 hours after the operation, we made cholecystograms in all of the six animals every 2 to 3 days for a week or more, and then at longer intervals over a period of 1 month. The earliest recognizable gall-bladder shadow appeared 4 days after operation in one of the dogs whose gall bladder had been curetted and closed. Feeding a meal rich in fat caused the shadow to disappear in 2 hours, though it did not reduce appreciably in size during emptying as is the case with the normal gall bladder.

A second animal of this group first showed a shadow on the fifth day. Again after 11 days

[1] We wish to express our indebtedness to Dr. James C. White of the Massachusetts General Hospital for the records of two of the cases.

TABLE OF CLINICAL DATA

Case	Age	Sex	Time since gall-bladder drainage	Diagnosis at time of gall-bladder drainage	Symptoms since gall-bladder drainage	Cholecystographic report	Operative report	Pathological report
1	37	♀	16 months	Cholecystitis, cholelithiasis	Moderate gastro-intestinal disturbance	Gall bladder not visualized. Probably diseased.	Adhesions and chronic thickening of gall bladder	Chronic cholecystitis.
2	61	♀	10 years	Cholelithiasis	Typical colic, severe	Faint shadow; no contraction after food. Several negative shadows; cholelithiasis, cholecystitis	Adhesions; walls slightly thickened; many small stones	Chronic cholecystitis, cholelithiasis.
3	48	♀	18 months	Many gall stones	Relief for 1 year, attacks of colic for 6 months	Gall bladder not visualized, probably diseased	Marked thickening of gall bladder; many dense adhesions	Acute and chronic cholecystitis.
4	28	♀	3 years	Acute cholecystitis, cholelithiasis	Slight	Faint shadow suggestive of cholecystic disease	No operation	None.
5	49	♀	5 years	Many stones	Typical colic, severe	Faint shadow with several negative shadows; cholecystitis; cholelithiasis	Thick walled gall bladder with many adhesions and 8 stones	Chronic cholecystitis cholelithiasis.
6	34	♀	1 year	Negative gallbladder, hæmachromatosis of liver	No gall-bladder symptoms post-operative hernia	Gall bladder not visualized, probably diseased	No operation	None.
7	38	♀	5 years	Several small stones	No symptoms for 4 years, vague symptoms 1 year	Faint shadow of about half normal density; no negative shadows	No operation	None.
8	42	♀	12 years	Many stones	Some symptoms for 1 year with typical colic	Gall bladder not visualized; probably diseased	Marked thickening of gall bladder with 3 large stones	Obliterative cholecystitis, cholelithiasis.
9	68	♀	25 days	Gall stones found accidentally while operating for duodenal ulcer	None	Faint enlarged shadow; moderate contraction after food (Fig. 2)	No operation	None.
10	50	♀	12 years	Many gall stones	None	Faint shadow about half normal density; no contraction after food (Fig. 3)	No operation	None.
11	55	♀	19 years	Many gall stones	Moderate symptoms for 1 year	Faint shadow; no contraction after food	No operation	None.
12	53	♀	10 years	Cholelithiasis	No symptoms for 10 years, then acute hæmorrhagic pancreatitis with drainage, followed by typical gall stone colic and cholecystectomy	Very faint shadow with fine mottling; cholecystitis; cholelithiasis. (Taken after the attack of pancreatitis, just before cholecystectomy)	1st operation: fat necrosis; necrosis of middle portion of pancreas. 2nd operation: enlarged gall bladder with adhesions; many stones	Chronic cholecystitis, cholelithiasis.

a shadow was produced which persisted for 24 hours, the animal having been fed meat. This is perhaps a slightly delayed emptying. Upon sacrificing the animal, a postmortem examination showed the gall bladder to be somewhat shrunken, and though the mucous membrane was regenerated, there was considerable fibrosis with mononuclear infiltration of the submucosa. The muscularis, however, was normal.

The third dog in which curettage of the gall bladder was performed, followed by closure, showed no shadow of the gall bladder up to 6 days. The test was not repeated until a month had passed, when a positive cholecystogram was produced. Cholecystectomy was done, the gall bladder being found in a mass of adhesions. Its wall was 2 to 3 millimeters in thickness. The mucous membrane in this case had also regenerated.

The two animals in which the mucosa had been curetted followed by drainage gave shadows after the tubes had sloughed out at the end of 7 days.

In the dog in which the mucosa had been dissected out *en masse* no cholecystogram

could be produced, though several trials were made. Autopsy 2 weeks after the operation showed a markedly shrunken gall bladder with a capacity of only 2 to 3 cubic centimeters. The wall, including the muscular coat, was greatly thickened and the submucosa markedly infiltrated with fibroblasts and mononuclear leucocytes. The mucosa had regenerated, but the small cavity contained only mucus though the cystic duct was patent.

DISCUSSION

The production of a cholecystogram clearly depends upon the concentration of the opaque dye in the gall bladder. As might be expected these experiments indicate that the mucous membrane is the necessary factor for this concentration. Furthermore, in patients in whom the cholecystogram is faint the gall bladder will generally be found partly denuded of epithelium.

On the other hand, a slightly abnormal gall-bladder wall does not apparently inhibit shadow formation unless it is so shrunken and fibrotic as to hinder the expulsion of its contents by muscular contraction, and thus prevent refilling of the viscus with bile, as illustrated by the last experiment described.

That the out-flow of bile is due to muscular activity of the organ has been shown: by the expulsion of iodized oil after feeding; by elongation with contraction rings during emptying and relaxation during rest (6); by the action of smooth muscle stimulants (2, 6, 7, 8); and by the measurement of pressure changes in the gall bladder during digestion (3).[1]

Slight injury to the wall of the gall bladder induced mechanically, in experimental animals, delays emptying after feeding (6); with severe injury resulting in fibrosis, the inhibition is marked. This may justify the assumption that in those cases of our clinical series in which the shadow failed to contract normally after the taking of food (Fig. 3), the musculature of gall bladder was damaged by sclerosis. The rule, however, is not infallible since it has been observed that in experimental animals in which digestion is disturbed for any reason, the gall bladder, though normal, may not empty (6).

Nevertheless, on the basis of the cholecystographic records, coupled with what we now know of the physiology of the gall bladder, it is safe to say that the clinical cases which showed faintness of the shadow and failure of contraction after taking fatty food (Table Cases 10 and 11), had abnormal gall bladders. It is also probable that those showing merely a faint shadow (no fat having been given) were abnormal. The mucous membrane of the gall bladder in these cases may have been impaired; or the faintness of the shadow may have been due to sclerosis of the musculature resulting in incomplete emptying, and consequent slight refilling of the viscus with bile containing the opaque dye.

SUMMARY

1. Cholecystograms were made on twelve patients at varying intervals, following cholecystostomy. Not one of them showed a normally functioning gall bladder as demonstrated by the cholecystogram.

2. Six of the patients experienced a return of symptoms severe enough to necessitate surgical relief. Four of these showed a recurrence of gall stones at operation; the remaining two showed fibrosis and thickening of the gall-bladder wall, the microscopic diagnosis in all cases being chronic cholecystitis.

3. Laboratory experiments were undertaken to study the effect of different types of injury to the gall bladder upon subsequent cholecystograms and thus to obtain further evidence as to the significance of the findings in those patients in whom no operation was performed. It was found that a severely damaged mucosa prevented shadow formation, and that injury to the musculature of the gall bladder inhibited emptying after the ingestion of fat, the conditions being as nearly comparable as they could be made to the cholecystic disease in the patients not subjected to operation.

In conclusion it would seem that the drainage of a diseased gall bladder with the expectation that it will regain its normal function is not only a futile procedure but one that endangers the future health of the patient.

[1]Since this article was submitted for publication G. M. Higgins and F. C. Mann have reported observations of muscular contraction in the exposed gall bladder of the guinea pig and the dog. Am. J. Physiol., 1926, lxxviii, 339–348.

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RECURRENT ANTERIOR DISLOCATION AT THE SHOULDER

Operative Cure by Bone Graft

By KELLOGG SPEED, M.D., F.A.C.S., Chicago

If we agree with a recent writer (19) that a dislocation at the shoulder is not a simple matter, how complicated appears recurrent dislocation. The patient with the habitual dislocation suffers not only the loss of power and efficiency in his arm which is associated with a single dislocation, but he has also the reiterated experience of pain and distress from the recurrence, plus the constant fear of its happening. If one person out of eight who suffers this injury goes on to a condition of habitual dislocation, the search for a cure still intrigues us.

Probably all agree that anterior shoulder dislocation takes place when the arm is in abduction. Heretofore much stress has been laid on the supposed importance of the capsule of the shoulder joint in both acute and habitual dislocation. The capsule does not really hold the head of the humerus to the glenoid as it is much too lax. All the muscles of the shoulder girdle help hold the arm up to the scapula but most important are the subscapularis, the supraspinatus, infraspinatus, and teres minor.

If we consider arm action as that of a lever, with a base taken at the glenoid of the scapula, it is necessary for efficient motion that this base be held steadily and firmly. The scapula has no direct bony connection with the skeleton except through the clavicle via its sternal end. Consequently, it must be steadied largely by muscular action.

The levator anguli scapulæ pulls up the superior posterior border of the scapula and thus tips the glenoid downward. The pectoralis minor (the pull on the coracoid) tends to pull the glenoid downward. The rhomboids pull the scapula toward the spine and also tilt the glenoid down. The trapezius raises the scapula, tilts the acromion and the glenoid upward. The serratus magnus swings the outer portion of the scapula backward, and tilts the glenoid up. These last two muscles acting together raise the base of the lever (the scapula) and steady it at a higher level, thus permitting the continuance of abduction from 90 to 130 degrees. After arm abduction of 130 degrees, the scapula ceases to move outward to any great extent and the greater tuberosity of the humerus is felt to slip under the acromion; that is, the trapezius has merely raised the acromion up in order to give more room for the rotating humeral head, and thus the head is able to slip under the acromion to go into further abduction. The external rotators and the subscapularis wrapped around the humeral head pull it down in abduction from the acromion to the glenoid and thus permit the fulcrum to be made steady and further abduction to follow.

In the ordinary type of abduction with the hand in pronation the greater tuberosity of the humerus strikes against the lower side of the acromion when the arm has swung up to about 90 degrees. Further motion of abduction is impossible unless the acromion is lifted and the entire scapula is rotated outward. The trapezius does this. The serratus and short rotators aid in this same movement and the clavicle also rises. The scapula is fixed in this position and abduction from 90 to 130 degrees may take place. There restriction is met again because the tuberosity still impinges against the acromion and the acromion has gone its limit. By externally rotating the humeral head so that the hand is in supination, the groove between the greater and lesser tuberosities comes into line with the acromial tip and there is just clearance enough to permit further abduction of the arm as the greater tuberosity rotates under the acromion. The muscles used in this last abduction with the hand in supination are deltoid, biceps, pectoralis major, and triceps.

Consequently, in hyperabduction with primary anterior dislocation following, the first step is an *inferior* dislocation; the capsule is torn away from the glenoid rim, not the humeral head, and the tear may extend clear up the coracohumeral ligament.

Practically all falls occur on the pronated and slightly internally rotated hand, so that when the hand is forced into abduction in the fall, the greater tuberosity strikes against the acromion and a break may be avoided by means of the relaxing reaction in the scapula permitted by its controlling muscles. Slipping past of the head of the humerus is not allowed and the hand does not come into supination. The greater tuberosity may be thus broken off. But if it is not, and none of the structures give, the pressure continues and the fulcrum established in the acromion may be broken off or the lever (humerus) may break off high up in the neck. Should no fracture occur in this final position of abduction, the supraspinatus muscle is relaxed, the humeral head slips down and the inferior portion of the shoulder joint capsule is made very tense and possibly torn and the head of the humerus is levered downward onto the rim of the glenoid. Then follows a movement of external rotation of the arm and the head is twisted out of the glenoid through the inferior portion of the torn capsule. To permit this dislocation there must be a great strain on the supraspinatus tendon or even a tear in it.

Inquiry at the time of a second and continued habitual dislocation at the shoulder is not particularly enlightening. After a few weeks up to a year, the subsequent dislocations may appear and lead to an establishment of recurrence. The trauma may be major in character or the result of a slight motion of abduction such as that of putting on a coat or reaching for an object. The theories of the cause of the habitual character of the dislocation may be divided into the following, and each idea claims the support of clever surgeons:

1. Defects in the head of the humerus, either acquired after first dislocation or congenital.

2. Defects in the glenoid cavity consisting of either acquired fracture of the edge, or shallowness of a congenital type.

3. Rupture of the insertion of the external rotators of the head of the humerus.

4. Avulsion of the greater or lesser tuberosity of the humerus with or without rupture of the insertion of the external rotators of the head of the humerus.

5. Detachment of the joint capsule from the anterior margin of the glenoid.

6. Enlargement of the joint from capsule relaxation following tears which have been given insufficient time for strong cicatrization or have been followed by repeated stretchings without real rupture.

While this is one of the oldest conditions for which surgical procedures have been devised, all established operations for cure may be divided into three groups.

In the first group come the capsular reefings, resections, plications, and shortenings, some done with, some without, opening the joint. To them may be added on occasion removal of loose bodies in the joint or other bony repairs in the neighborhood of the shoulder.

In the second group are the operations upon muscles in the nature of plastics or transpositions of insertions. To this may be added the building of check ligaments of transplanted fascia or silk. All these have as their object effect upon shoulder movements. Abduction beyond normal humeral motion is restrained or completely inhibited or the muscle tightening in such motions leads to restraint applied on the head or neck of the humerus, with the object of holding it back from the action of dislocation.

In the third group are the arthrodesis operations upon the shoulder joint, a substitution of a stiff joint for the enormous uncertainty of one which dislocates on slight cause with resulting disability and pain.

Thomas (20) recently said: "But if the arm is carried forcibly into abduction before the cicatricial healing (of primary dislocation) is strong enough to resist stretching of the scar, with or without slight tearing of this new cicatricial tissue, a new dislocation develops from a degree of force much less than necessary to produce the first dislocation." That investigator believes that the usual anterior recurrent dislocation is due to a traumatic cicatricial, anterior hernial pouch of the capsule, and that the object of any attempt at cure should be to obliterate the hernial protrusion, incidentally, of course, removing at the same time any free or attached bony body in the joint.

Recently Pilz (15) reviewing 18 instances of this trouble, 3 of which were bilateral, which has appeared in Hildebrand's Clinic in Berlin from 1913 to 1925, considers that all patients thus afflicted should be subjected to careful X-ray study for bony defects in the head of the humerus. In the 21 shoulders, 15 presented definite bony defects in the head.

Deformity of the head of the humerus had often been noticed in habitual dislocation. Loebker and Riedinger interpreted it as a result of the frequent recurrence of the dislocation and pressure on the head. Volkmann, Kramer, Mueller, and others considered the deformity to be a fracture of the head, while yet others believed it to be a congenital deformity between the anatomical neck and the greater tuberosity, not the result, but the cause of habitual dislocation.

In 1920, de Fourmenstraux (2) claimed that he found such a head defect in 4 out of 80 roentgenograms of normal shoulders and thought it was a real factor in causing dislocation.

Nearly every one studying the subject has admitted that fracture of the glenoid rim, especially the anterior margin, usually with capsule laceration, may favor habitual dislocation. The glenoid has been reshaped and deepened in efforts to extract a cure. Hildebrand (8) thus treated two patients who recovered without recurrences.

Ever since recurrent dislocation has been known, surgeons have considered that the shoulder joint capsule was at fault. Laying aside a complete historical review of the interest in the capsule, we find that within the last few years many articles favoring capsule repair for laxity or tear to give complete cure have been published. Gerster's article (3) was the first. Riviere (18) treated the condition by simply suturing or pleating the capsule both above and below the subscapularis tendon and immobilized the arm for 21 days in a sling. His patient had no dislocation up to 16 months after operation although he had by that time indulged in gymnastics. Thomas (20) in many articles favors capsule operation. He says capsulorrhaphy was successful in 66.5 per cent of epileptic patients with recurrent shoulder dislocation and a failure in 6 patients, 33.5 per cent. Henderson (5) subjected all of his cases to X-ray examination, but found no evidence of bony injury. He is an ardent advocate of capsulorrhaphy and in 1921 had operated upon 26 shoulders (6). In some instances he added lengthening of the pectoralis major tendon as advocated by Young. He said: "It is probable that muscle pull or relaxation of the shoulder capsule above has not been sufficiently considered in the treatment. It is reasonable to suggest therefore that the pectoralis major, teres major, and latissimus dorsi be lengthened and if thought necessary, the region of the capsule where the supraspinatus and infraspinatus are inserted; and that the anterior part of the capsule be reefed."

Among other recent advocates of the capsule operation is Valtancoli (21). In a total of 140 cases of traumatic shoulder dislocation, he used the operation on 16 shoulders in 15 persons. Of 15 cases, 13 were operated upon by a fascial transplant placed across the front of the joint. This transplant was obtained either from the deltoid fascia or the fascia lata. Keller (10) advocates a crucial plication of the shoulder joint capsule on the anterior surface, using Thomas' posterior axillary incision for approach.

Placing confidence in muscle plastics, perhaps encouraged by Clairmont's original operation in 1908, a small school have come into existence who advocate muscle transplantation about the shoulder. Ollerenshaw (13) believes in muscle flap operations, inasmuch as they provide (1) a good sling to brace up the head and neck of the humerus and (2) a muscular sling which contracts with the rest of the deltoid in action. This second point the writer believes is not properly taken as such an attempt at muscle transplantation violates all the physiological and technical laws of such procedures.

Clairmont's original description of this operation divided it into two steps. An anterior incision splitting the deltoid was made and the insertion of the pectoralis major was divided downward to expose the so-called quadrilateral space in front. This space was opened up and enlarged downward by dividing the upper edge of the tendon of insertion

of the latissimus dorsi and the teres major for ¾ of an inch. The anterior circumflex artery was seen and made the upper limit of the wound. The patient was then turned on his side and the second part of the operation was performed. Through an incision parallel to the posterior edge of the deltoid 4½ inches in front of this line, the deltoid was split as far up as the circumflex nerve and down to its insertion into the humerus. The outer head of the triceps insertion was separated and a channel was made into which the flap of deltoid could be drawn by a forceps passed through toward the anterior surface and attached behind.

Armour reported 2 such cases operated upon by Sir Robert Jones in 1914, with recurrence within a few months in 1 case. Ollerenshaw has not allowed his patients early active joint motions nor more than 60 degrees of abduction for 1 month after the operation. In epileptics this restraint is maintained for 2 months. He believes that recurrences are caused by loss of muscular balance associated with capsule laxity. With this method the shoulder joint is not opened.

In the discussion of Ollerenshaw's paper Bristow said: "What is the action of the deltoid afterward? The fact that the slip of deltoid contracts when stimulated with faradic current on the table has no bearing on the function of the muscle, because if you cut a nerve and stimulate it, the muscle will contract. The cortex and higher centers do not deal with separate muscles but with *movements*. What you actually do by this operation is to put a nice big lump of ragged muscle under the capsule, and the effect is to strengthen the part, and in addition as you will probably have some hæmorrhage, you will get still further strengthening by the formation of some fibrous tissue. I think that the results of this operation depend on the pad of muscles rather than on any specific action of the transplanted slip."

Mandl (12), while recognizing the necessity for individualization in the treatment of these dislocations uses Finsterer's operation. The head of the humerus is held back by a band on the anterior surface of the joint (to take the place of a normal joint capsule) composed of a part of the coracobrachialis and part of the biceps. Finsterer reported 11 cases thus treated with no recurrence for 6 to 7 years in 2 cases, for 3 years in 3 cases, and for less than 3 years in 2 cases. In the last 4 years Mandl has performed 7 operations on 6 patients. Two had no subsequent dislocations, 4 had 1 dislocation after 4 years, and 1 patient had a recurrence after 3½ years.

Through a finger length incision at the outer border of the scapula through skin, fat and fascia, the latissimus dorsi muscle appears. Hofmann (9) cuts through this muscle, closes the wound and puts the arm in a position of slight abduction. His patient had no dislocation up to 6 months after operation. In place of muscle strips to hold back the head of the humerus, one may use strips of fascia or silk strands to act as check ligaments or restraints on the head. Rich (17) used a check ligament after noting that the capsule of the joint in these patients was not always lax and could not always be plicated. He believed that the glenoid edge or the tendon of the infraspinatus, subscapularis, and teres major were often torn and that any or all of these factors lead to recurrences. Consequently he employed a double band of silk ligatures between the scapula and the humerus to restore unity of action of the shoulder girdle muscles and to prevent abduction. The silk was so placed that it acted as a network for periosteal grafts. When sufficient new bone formed the result was that a bony bridge between these two bones precluded the possibility of the scapula failing to accompany the humerus in its upward excursions.

Acting on this suggestion and feeling that most of the resistance at the shoulder against dislocation lay in the muscles and not the ligaments and bone, Gibson (4) used Rich's operation. He said: "If some measure could be adopted whereby as soon as the deltoid goes into action an automatic guard is supplied to the under aspect of the joint capsule, this automatic guard not interfering with the free movements of the joint at other times, a much better solution of the problem would be attained than by limitations of the range of movement. Such an automatic arrangement is provided by the Clairmont-Ehrlich opera-

tion, in which a portion of the deltoid itself is employed as a muscular guard. The deltoid is hoist with its own petard."

Plummer and Potts (16) in 2 cases of recurrent dislocation used a fascial strip passing from the greater tuberosity of the humerus to the acromion process of the scapula as a restraining ligament. A few months later Wuelfing (22) (crediting Joseph, 1917), to fasten the head of the humerus in habitual dislocation, used a strip of fascia lata extending through the head to the acromion across and through the front of the joint capsule somewhat on the order of Schmieden's or Loeffler's methods. Three cases were operated on according to each fashion.

Loeffler's description (11) was of Joseph's operation. This procedure involves opening the joint capsule, boring a hole through the head of the humerus, and passing through it a strip of fascia lata which is tightened to the acromion process and holds the head like a sling. This method he considered much like the establishment of a ligamentum teres in the hip joint. Possibly he neglected to inquire whether or not the ligamentum teres may not be a philogenetic affair with no restriction of the hip from dislocation. When thus inserted in the shoulder, a strip finally absorbs. Loeffler consequently in his own operation used a band of fascia stretching from the greater tuberosity of the humerus to the acromion which would prevent anterior dislocation at the shoulder. He performed this procedure successfully on an epileptic 25 years old who had habitual anterior dislocation.

In 1922 Herfarth (7) reported 3 cases operated upon by Loeffler's method. There were no recurrences up to the time of printing.

The fourth group of operations for cure of this condition, bone transplantation, is a relatively unexplored field. In 1924 Oudard (14), while apologizing for suggesting a new operative method, claimed that his was surer. He acknowledged that many cases should be studied before the true pathological anatomy could be ascertained, but admitted that at operation one could not explore the whole shoulder region to check up all points. In patients who present an atrophy of the subscapularis muscle or a deformity of the head of the humerus (a deformity of the head or capsule being always present), the head should be guarded during a capsule operation by the creation of a bony buttress. This would prevent recurrence by precluding dislocation whether the capsule remained inefficient or not.

Oudard's technique consists in the section and then doubling over of the subscapularis tendon, which thus shortened and reinforced maintains its proper action. To obtain sufficient exposure the deltoid must be partly cut through as the deltopectoral space does not give sufficient room. If care is taken to cut the deltoid 1 centimeter below its clavicular insertion, its reconstruction is simple and sure. Second, to lower the coracobrachialis and pectoralis minor the tip of the coracoid is sawed off. When these muscles are lowered and the nerves are retracted the subscapular muscle comes into view.

For a bony block of the front of the joint a transplant is needed for placing between the base and sawed off tip of the coracoid. Such a transplant in contact with two well nourished bony surfaces is in a most favorable situation for growth and consolidation. A bone transplant 3 to 4 centimeters long is sufficient when placed in the coracoid to oppose all projection forward of the head of the humerus. An objection might be raised that the graft would be too fragile and would break when violent motions are performed. That is not found to be so. Nor does the muscle lowering (3 muscles attached to the coracoid) cause disturbance, as they quickly adapt themselves to their new length.

In all his cases the results were excellent, 2 years having elapsed since the first operation with no recurrences. His patients have no muscle atrophy, they can perform gymnastic exercises, and the head of the humerus has as wide a range of motion as the sound shoulder. Extending below the coracoid can be felt a vertical bony ridge corresponding to the inserted graft.

Eden's article (1) reported his operation first performed in 1917. A bone transplant 2 by 2½ by 5 centimeters was placed under the raised periosteum of the neck of the scapula so that ½ to 1 centimeter stuck out in front

Fig. 1. The writer's first patient at the time of admission with bilateral anterior dislocation.

Fig. 2. The first patient 6 months after bilateral bone transplant operation for habitual anterior dislocation. There was no restriction of shoulder joint movement. It is evident that the pectoralis major muscles are active.

of the joint. He also reefed the capsule and kept the arm abducted for 3 weeks in a plaster dressing directed slightly forward and in rotation midway between outward and inward. Two of his patients had then gone 3 years without recurrence.

These many methods applied to this condition of recurrent or habitual shoulder dislocation probably prove that not one is eminently satisfactory. It has been found that reefed, scarred, or shortened joint capsules, previously stretched and atrophic, will not always hold the humeral head to the glenoid. Most of the muscle transplantations have not been physiologically correct and consequently have been found inadequate as permanent cures. Arthrodesis is an acknowledgment of defeat and I question whether it is ever indicated.

Lacking a procedure for securing firm and lasting restriction of excursion of the head of the humerus which will prevent it from slipping out forward through the stretched and weakened capsule into habitual dislocation when the arm is hyperabducted, one naturally turns to a method of mechanical blockage. The usual avenue of exit lies along the lower anterior edge of the glenoid fossa. Such a method appears especially valuable when the anterior or inferior glenoid edge is broken off at the time of the original dislocation. The lack of support at the shoulder following this complication is of great aid in favoring recurrent dislocation. Three years ago when performing a radical operation for carcinoma of the breast the writer independently conceived of a blocking method by bone transplant.

THE OPERATION

In muscular men an incision is made from just below the coracoid process straight down about 4 inches through the skin, superficial fat, and fascia. The edge of the pectoralis major muscle is then identified at the lower angle of the incision. By blunt dissection the left index finger is pushed up under the muscle until its upper border is reached and at the

Fig. 3. Bone transplant under edge of glenoid one year after operation by Eden's method.

Fig. 4. Bone transplant under the glenoid edge one year after operation for habitual anterior dislocation. This was Case 4 of Dr. Phemister's series. The bone appears to be alive and firmly attached.

point of junction with the deltoid the finger is hooked through and the muscle is cut transversely across its fibers about 1½ inches from the tendinous insertion into the humerus.

Retraction of the muscle ends exposes the axillary contents. The nerves and blood vessels are gently held out of the way and the edge of the glenoid fossa is palpated deep in the wound above the axilla. By blunt dissection all important structures being avoided, this glenoid edge is brought into view. The capsule of the shoulder joint is usually not opened.

In women the approach through the deltopectoral junction across the shoulder usually affords sufficient space upon retraction. A broad drill point or chisel is then inserted into the scapula just anterior to the glenoid edge near its lower margin. A hole is drilled about 1 inch deep diagonally into the neck of the scapula. Into this is inserted a bone transplant removed from the anterior surface of the tibia. The transplant is driven home and about ¾ of an inch is left projecting anteriorly and obliquely across the lower anterior margin of the shoulder joint. This in no way interferes with normal range of shoulder joint motion, *but it does prevent the head of the humerus from slipping out forward into anterior and habitual dislocation.* The anterior capsule may be exposed and sutured if it is considered necessary as an extra precaution. Any active hæmorrhage is checked. The great pectoral muscle is sutured by mattress stitches of heavy catgut, and an accurate re-approximation thus made. The pectoral fascia is then sutured by a running stitch of lighter catgut, the skin is closed with black silk, and a capillary drain left near, but not exactly at, the lower angle of the wound. The arm is held in a sling close to the chest after the wound is dressed.

Within a week the forearm is removed daily from the sling for elbow joint motions. After 12 to 14 days, active abduction of the arm is requested, and after 3 weeks no arm support of any kind is used, abduction of the arm being encouraged. Within 4 to 5 weeks after operation the arm can be actively abducted beyond a right angle and full action of the pectoralis major returns. Ultimately complete elevation of the arm becomes possible and no degree of hyperabduction leads to another dislocation.

What is the fate of the bone transplant? Does it all ultimately absorb? Does new bone grow out along it, making a spur in front of the glenoid? It certainly meets some functional demand and should grow and live. The transplant keeps the shoulder reduced and the capsule ultimately shrinks and also aids in holding the head of the humerus in the joint.

EDEN'S TECHNIQUE

"An oblique incision is made over the anterior surface of the shoulder along the line of

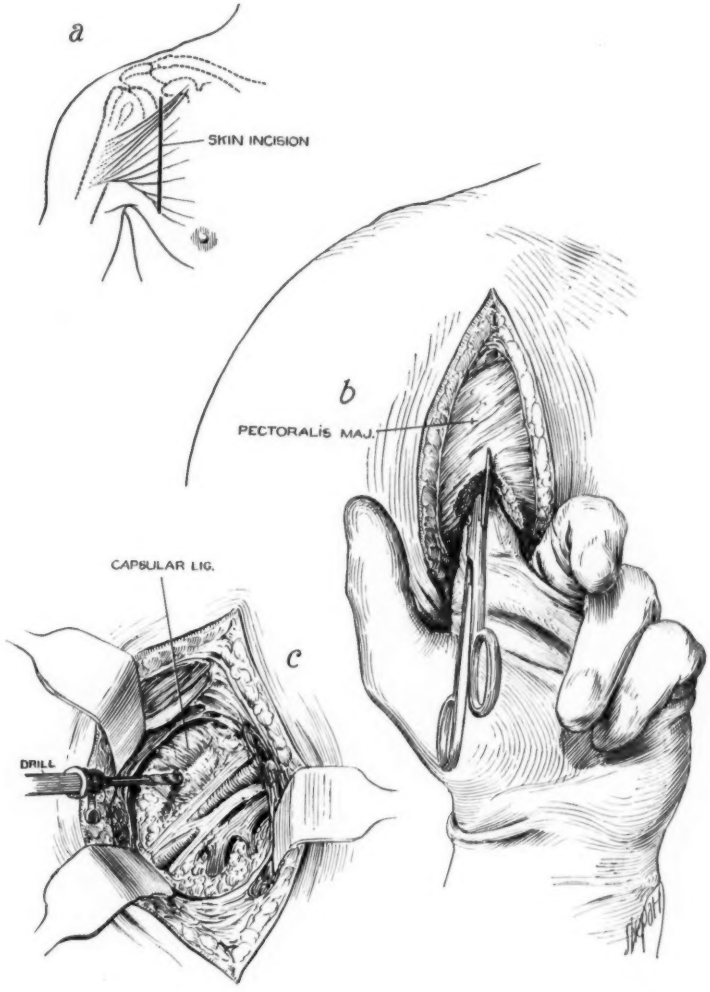

Fig. 5. The writer's operation showing line of incision, *a*. *b*, Index finger of left hand hooked under the pectoralis major muscle which is being cut through. *c*, Severed pectoralis major muscle retracted, showing the lower anterior surface of the shoulder joint above the vessels and nerves. The drill is being inserted into the scapula just below the insertion of the capsular ligament.

junction of the deltoid and pectoralis major and the front of the joint is exposed by retraction of these muscles. The lower portion of the subscapularis muscle is separated from the front of the capsule and retracted upward, exposing the baggy portion of the capsule. The capsule is incised and the antero-inferior margin of the glenoid located. A ¾-inch incision is made in the capsule at its insertion and a pocket is made by separation of the periosteum from the neck and first portion of the body by means of a chisel. A graft approximately 2 inches long by ¾-inch wide is cut from the upper part of the anteromesial

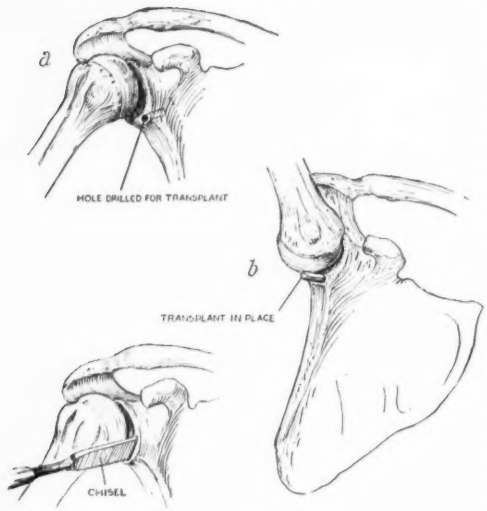

Fig. 6. *a*, Schematic view of the skeleton at the shoulder, indicating the site of insertion of the bone transplant. *b*, The arm fully abducted with outward rotation of the scapula, showing the guarding action of the bone transplant to prevent the head from slipping down out of the joint at the inferior margin. The lower left hand figure shows the method of inserting the chisel after exposing in front of the joint. The bone flap is bent forward and the transplant is inserted into the slot remaining where it may be fastened with catgut if it is wished.

surface of the tibia and one end is tapered with a bone-cutting forceps. A hole is bored through the graft 1 centimeter from the broad end and a cutgut suture passed through it. The graft is then inserted into the pocket and stitched to the capsule by means of the catgut suture. This allows the end of the graft to project slightly beyond the lower margin of the glenoid. The capsule is then plicated with interrupted catgut sutures and the wound closed. The arm is bandaged to the side for 3 weeks and then carried in a sling for 2 weeks, after which motion is gradually begun."

Dr. Phemister, who uses Eden's technique, has kindly permitted me to include the following 4 case histories of patients on whom he has operated.

G. F., male, about 32 years of age, tall and slender, had had repeated dislocations of the left shoulder for 5 years with slight limitation of abduction. Findings otherwise were negative. Eden operation was performed on October 23, 1923, with complete return of function and no recurrence to date. Roentgenogram 6 months after operation showed fusion of graft with scapula.

P. S., male, age about 35, of medium build, muscular, had had epilepsy since childhood and had had numerous dislocations of both shoulders, some of which occurred during epileptic seizures and others as the result of excessive usage, particularly abduction. There was considerable limitation of motion in both shoulders, especially abduction. Operation was performed on both shoulders, January, 1922. There was slightly more limitation of motion in the right shoulder after operation than before, while motion remained about the same in the left arm. There have been no recurrences of the dislocations.

J. N., male, age 32, had had 16 dislocations during the previous 7 years. The patient was afraid to abduct the arm because of danger of dislocation. Operation March 18, 1925, was followed by gradual increase in range of motion to nearly what it was before operation, except abduction, which was limited to 110 degrees. A slipping sensation is felt in the joint when pressure is made in the long axis of the extended arm. An examination January 7, 1926, showed lateral elevation to 110 degrees, forward 125, and almost normal backward elevation. Rotation is fairly free, about 50 per cent of opposite joint. He works as sprayer of electric light fixtures. He has had no recurrence but states that he cannot put any pressure on the arm toward the shoulder joint with the arm in the extended position because he notices a slipping sensation upward and backward.

A. F., 28 years old, had his first shoulder dislocation when 16 years old, while playing basket ball. He was able to reduce it himself. Two years later a second dislocation occurred, which he was again able to reduce himself. Since then dislocations have been frequent, occurring 6 times in the last year. Excessive violence is no longer needed to produce the luxation. On January 29, 1923, the X-ray examination showed a fragment of detached bone lying in the lower part of the shoulder joint. It was impossible to say whether this was from the glenoid or the greater tuberosity. He was operated upon at that time and in addition to the bone transplant the joint capsule was reefed in the longitudinal axis by means of 4 chromic sutures. There has been no recurrence to date."

The anterior approach used by the writer certainly offers a very clear view of the shoulder joint region. The bone transplant need not be so large as that used by Eden, and its fixation is secure in the drilled hole or chiseled hole along the neck of the scapula. If desired, capsule suture or subscapularis shortening may be performed.

Three cases in which the author has used his own operation are reported.

Case 1. M. T., 27 years old, a newspaper seller, was admitted to the hospital February 28, 1925, with an anterior dislocation of the right shoulder and a history of habitual dislocation of both shoulders for the last 4 years. He is an epileptic. During fits sometimes one or both shoulders were dislocated. At other times, some slight trauma such as a pull on his arm or rolling over in bed would cause dislocation at the shoulder. He was a rather poorly nourished active young man otherwise in good health. Physical and laboratory examinations revealed no abnormalities. Some 15 years before he had suffered from osteomyelitis of the left tibia, long since completely cured. An effort was made to have his right shoulder operated upon by the method described, but he refused all our advances and left the hospital after the right shoulder was reduced. On June 2, 1925, he was readmitted, this time with an anterior dislocation at the left shoulder caused by trying to pick up a pin from the floor without bending over completely. This dislocation was reduced and again operation was refused. On July 11, 1925, he was readmitted after an epileptic seizure while riding in a car at 5:45 a. m. A subcoracoid dislocation at both shoulders was present. This time he finally consented to operation. The right shoulder was operated upon first and the bone transplant 2 by ⅜ by ½ inches was implanted in the right shoulder. The wound healed kindly and within a month the left shoulder was similarly treated. Since that time he has had no dislocations, although he has had several severe epileptic seizures. A roentgenogram in February, 1926, shows the bone transplant in its proper position.

Case 2. C. M., 26 years old, a cooper, was admitted to the hospital January 13, 1925, with an anterior dislocation at the left shoulder which was promptly reduced. He gave a history of habitual dislocation at this point and the roentgenogram showed a slight fracture of the anterior rim of the glenoid and displacement downward of a small bone fragment. He refused operation. On April 6, 1925, he was readmitted, having been wakened in bed with a dislocation at the same shoulder. On September 2, 1925, he came back again, saying this left shoulder had been out of place for 2 hours, making the twenty-fifth time. This last dislocation occurred as he was putting on his coat. He was ready to try operative cure. On September 11, 1925, the operation described was performed. He made a prompt recovery and left the hospital September 20, 1925. Since then he has had no dislocations at this joint (4 months).

Case 3. This patient has been operated upon too recently to tabulate for results. Mrs. J., 30 years old, had her first dislocation at the right shoulder 8 years ago, caused by a fall from her horse. It received scant attention and no immobilization.

The advantages of this operation may be enumerated:

1. The joint capsule is not necessarily opened.

2. The bone transplant offers a living permanent block to the avenue of exit from the joint.

3. No tendons need shortening, no check ligaments with restricted joint motion are required, and no muscle transplants are necessary.

4. The divided pectoralis major muscle rapidly heals and regains power.

5. The functional return is rapid and as complete as before operation; early joint movements are possible.

6. The short and relatively bloodless operation through a moderate incision lowers the chances for infection.

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SARCOMA OF THE RECTUM

Report of Case With Review of the Literature

By J. H. WEEKS, M.D., Philadelphia
From Surgical Clinic and the Research Institute of the Lankenau Hospital.

EXCLUDING the melanotic type, rectal sarcoma appears to be exceedingly rare. Most of the literature on diseases of the rectum omit entirely the subject of sarcoma, or dismiss it with the statement that it has occasionally been found. Cases are exceedingly difficult to collect, for in many papers sarcomata have not been differentiated from other malignant rectal tumors. A review of the literature reveals 100 cases.

The rarity of the lesion is shown by a glance at the following statistics. In 840 cases of sarcoma, Guret found only 3 of the rectum. Nothnagel reported 274 cases of sarcoma operated upon in Vienna, among these, 3 were in the intestinal tract, but only 1 in the rectum. In Stockholm, 433 cases of sarcoma operated upon revealed 2 in the rectum. Among 100 malignant rectal tumors, Quenu and Hartmann did not find one sarcoma. Key, in 206 cases of malignant tumors, found 1 rectal sarcoma. Inquiries of 50 of the principal hospitals and museums of Great Britain and Ireland produced only 2 cases. Guret counted 399 cases of carcinoma to 3 of sarcoma. More important still are the statistics of d'Hochenegg who, from 1900 to 1907, operated upon 500 patients with malignant tumors of the rectum. In only 4 of this number was sarcoma proved microscopically, and in 2 of those Lapeyre declared the growth to be of the melanotic type. Verebely states that approximately one in every 200 sarcomata are rectal. A consideration of the above statistics shows that one rectal sarcoma is found in every 242 sarcoma cases. In 200 cases of malignant disease of the rectum, carcinoma is found approximately 199 times and sarcoma once. Of the rectal sarcomata the melanotic type is twice as frequent as are the other varieties.

HISTORY

Rokitansky in 1855 first separated sarcomata from a group supposed to be carcinomata of the rectum. He may have confused this group with tuberculous or syphilitic lesions, but there is no doubt that he succeeded in identifying malignant connective-tissue tumors. After Rokitansky's work, investigators failed to report their cases and no further data appeared until 1877.

D. Mollière in his *Treatment of Diseases of the Rectum and Anus* devotes several lines to sarcoma of the rectum. He states that the sarcomata observed by him were chiefly the "myeloid" forms. This proved the existence of the melanotic sarcomata. In terminating his article, he cites a case of osteosarcoma published by Wagstaff.

In 1887, Grenet first assembled the cases of rectal sarcoma. He reported 6 instances and the first permitted Trelat to give an important clinical lesson on the subject. He added that sarcoma may be either primary or secondary in the rectum. In 1892 Professor Tédenat, in a paper on tumors of the rectum, related a personal observation of a particularly rare rectal neoplasm which he believed to be sarcoma. This same year in the *Traité de Chirurgie* by Duplay and Reclus, Potherat wrote a page devoted to rectal sarcomata, and verified the assertions of Mollière and Grenet.

In 1899 Quenu and Hartmann divided their cases into malignant sarcomata, of which they had gathered 20 cases, and "non-malignant sarcomata," which they considered to be more rare, having gathered only 5 cases. This was the first work in which sarcoma had been classified into these 2 groups. What the "non-malignant" sarcomata were, is difficult to say.

A short time later several papers appeared in Germany devoted to sarcoma of the rectum, in which several "non-malignant" cases were reported: in 1901, a work by Heller and Maas; in 1902, a paper by Bardenheuer; and in 1903, a work by Brachmann.

In 1905, Key reported 3 new cases. Of these, 2 were melanotic and the other was a

Fig. 1. Sarcoma of the rectum showing the general structure of the tumor. Strands of fibrous tissue breaking up the network of cells and dividing them into "alveoli" of irregular size and shape. (×85.)

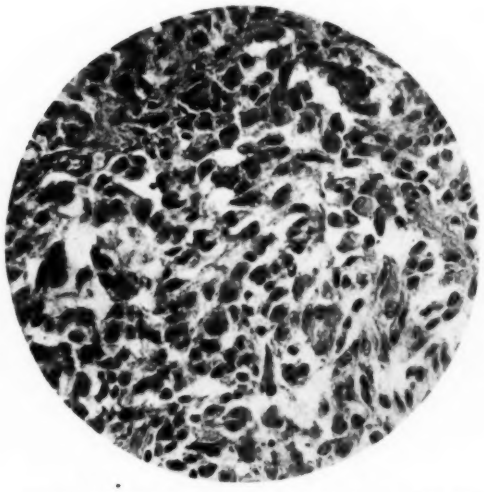

Fig. 2. Sarcoma of the rectum, showing the tumor and the type cell in detail. Type cell is large and spindle shaped, with pale staining, finely granular protoplasm. Nuclei are centrally located. Many nuclei show mitotic figures. (×235.)

large round cell sarcoma. He described these tumors in detail, discussed their rarity, and ended by giving a differential diagnosis. He completed his work in 1908 and at this time published a report of 58 collected cases.

James Thompson reviewed the literature in 1907, but found it very limited and unsatisfactory. He reported, in great detail, an alveolar, small, round cell sarcoma in a man aged 49 years. He found only 7 cases in the literature up to this date which were unquestionably sarcomata of the rectum. They are as follows: 1 ossifying sarcoma reported by Wagstaffe, 1 alveolar sarcoma by Esmarch, 1 mixed round and giant cell sarcoma by Tédenat, 1 spindle cell by Grenet, 1 spindle cell by Ball, 1 round cell by Key, and a sarcomatous polyp by Massabuan.

In 1908 Exner reported 4 new cases. In 1909 a work was published by Schumann dealing with pigmented sarcomata which gave a general review, and a complete exposition of the subject.

In 1911 Whiteford, Clavel, and Loques wrote articles on the subject. In 1912–13, an important work by Chalier and Bonnet appeared in the *Revue de Chirurgie* on the primary malignant tumors of the anorectal region. These were entered under epithelial tumors.

In 1916, Delbet, in his book on surgery, devoted a chapter to "non-malignant sarcomata" of the rectum, doubting the existence of the diffuse varieties.

Lapeyre, in 1920, reported two cases, one being a lymphosarcoma, the other a spindle cell sarcoma. He reported 30 cases of primary sarcoma of the rectum collected from the literature. Of these cases, 13 were round cell, 12 spindle cell, 2 lympho-, 2 myo-, and 1 osteosarcoma.

C. Hamilton Whiteford, in January, 1925, reported 1 case of large round cell sarcoma in a woman of 81. He cites 9 other cases that he was able to find in the literature and summarizes these 10 cases.

Hence we find that primary malignant neoplasms of the rectum are nearly always epithelial in origin, while connective-tissue tumors are comparatively rare. In the above review of the literature, approximately 100 cases of the latter have been recorded. If the questionable cases were discarded, it is certain that the number would be reduced over one half.

REPORT OF CASE

M. K., a well developed and well nourished Armenian grocer of 40, entered The Lankenau Hospital November 6, 1925, complaining of constipation, bleeding from the rectum, and pain on defæcation. Three months previously he had first noticed at defæcation, bright red blood not mixed with his stools. It was not until 1 month later that he noted constipation with pain on defæcation. He had lost no weight and had never complained of hæmorrhoids.

Physical examination was entirely negative except for the rectum, on the anterior wall of which, just internal to the external sphincter a pedunculated mass was felt. It was polypoid, soft, and bled easily.

November 7, 1925, the mass was removed by Dr. John B. Deaver and its base cauterized. Microscopic examination, showed it to be a large spindle cell sarcoma. After 2 weeks, nothing could be felt by rectal examination, and the patient was discharged. He was told to return to the X-ray department for treatment and to report monthly at the follow-up clinic for observation.

He received six deep X-ray treatments after discharge, but the above mentioned symptoms soon reappeared. On December 18, radium was applied. After this he could not move his bowels except with great difficulty, and he noted a large quantity of blood-tinged watery fluid passing constantly from the anus.

He was readmitted January 9, 1926. Physical examination was again entirely negative except for the soft polypoid masses of tissue on the anterior rectal wall, which were non-tender and bled very readily. All laboratory tests were normal, including negative Wassermann reaction.

January 11, 1926, he was reoperated upon, a modified Kraske being performed by Dr. Deaver. The growth was the size of a pigeon's egg with a base the size of a silver dollar. There was no evidence of metastasis at this time.

Operation was complicated by hæmorrhage. There was a steady venous ooze that could not be checked except by packing. Because of this, the wound was slow in healing, and gave an opportunity for prolonged observation of the patient.

On February 3, patient was doing well and gaining slowly in strength. X-ray examination of the chest was negative for metastasis. On March 15, patient complained of slight pain in his right chest. All physical signs pointed toward fluid at the right base. X-ray examination March 20 showed the right diaphragm very high with restricted movement. There was marked infiltration and congestion of both lungs, especially of the right. The aspirating needle was introduced and a few cubic centimeters of blood-tinged fluid withdrawn for diagnostic purposes.

On April 3, the liver edge could be distinctly felt. It was irregular and contained several discrete, hard, non-tender masses the size of an English walnut. About this time the patient became jaundiced. The masses grew in size as the jaundice gradually deepened. Patient continued to eat well, and while his strength was rapidly reduced, there was no rapid loss in weight as is noted in carcinoma. One week prior to death numerous small scattered masses could be felt beneath the skin. The patient died of toxæmia approximately 7 months after the appearance of the first symptom, viz., blood in his stools.

Unfortunately, we were unable to obtain permission for an autopsy.

Macroscopy. The specimen removed at operation consisted of a portion of the rectum together with three lower segments of the coccyx. The growth on the anterior rectal wall had a base approximately the size of a silver dollar. The mucosa was ulcerated and friable. Beneath the mucosa was a nodular mass which cut with considerable resistance. The cut surface was pearly and showed a moderate amount of fibrosis. No definite macroscopic architecture could be distinguished.

Microscopy. The general architecture of the tumor was that of wider strands of loose connective tissue dividing the growth into "alveoli" of irregular size and shape. Then thinner strands coursed through, breaking up the network of cells into groups. The cells in many places were typically combed. Capillaries were numerous, many walled by tumor cells. A number of tumor cell thromboses were scattered. Here and there were areas of necrosis. The type cell was large and spindle shaped, with pale staining, finely granular, protoplasm; the nuclei, centrally located, were usually vesicular, but occasionally showed mitotic figures. The cells were separate entities.

GENERAL CONSIDERATION

Sarcomata, as highly vascular, malignant neoplasms arising in connective tissue may originate in the subserous, muscular, or submucous coats of the rectum. They usually begin in the latter, beneath the mucosa. At first they are small, nodular masses, movable on the muscular coat and absolutely independent of the mucosa which is usually intact. As they progress, they eventually invade the mucosa, as shown by its failure to slide freely over the tumor. Ulceration then frequently occurs progressively reaching the surface. If pedunculated, the ulceration takes place at the top, sparing the base.

Sarcomata are, as a rule, hard in consistency until ulceration takes place, after which they usually become a soft spongy mass.

Sarcomata are much more common in the male than in the female in the ratio of about 1 to 5. Cases range between 35 and 81 years of age.

Sarcomata are rare in the rectum, usually not being recognized until inoperable, or, if

operated upon, not until a microscopic section has been studied. They are frequently confused with carcinoma, or with tuberculous or gummatous lesions. Sarcomata may be located in any portion of the small or large intestine. Verebely, in 106 cases of sarcoma, found the lesion located as follows: 36 in the appendix, 11 in the transverse colon, 55 in the sigmoid, 4 in the rectum.

DISCUSSION

The diagnosis of rectal sarcoma is seldom made, and, because of the rarity of the condition, is, in fact, seldom thought of. It is generally mistaken for carcinoma, and, in the majority of instances, this error is inevitable. Usually the lesion is not identified as sarcoma until a microscopic section has been made, as in our case.

There are certain signs and symptoms which should suggest its presence. These are enumerated below with an attempt at a differential diagnosis.

The history may often furnish a clue as to the true nature of the neoplasm. Defæcation difficulties are rather early and pronounced on account of the position of the tumor and its tendency to become voluminous and block the lumen of the bowel. Pain comes later, for sarcoma has not the tendency to invade the mucosa as do carcinomatous lesions. Bleeding is also a late symptom and does not make its appearance until ulceration has taken place.

Careful physical examination is of the utmost importance. Sarcomata are unique tumors. They are situated low down in the rectum just above the anal opening. They develop rapidly, show a tendency to pedunculate and to obstruct the rectal lumen. Often, notwithstanding the size of the mass, the rectal mucosa slides easily over the growth which is generally movable. Carcinomata tend to be fixed and ulcerate early. The inguinal glands are never enlarged in sarcoma; they may be in rectal cancer. There is not the same degree of cachexia in sarcoma as in carcinoma.

More often the clinical picture is not at all clear cut; it is then that confusion arises. Sarcoma is frequently mistaken for hæmorrhoids, and many patients have been treated for this condition when sarcoma was really present. A careful physical examination should readily disclose the neoplastic nature of the lesion, and rectal examinations, especially for sarcoma, should never be neglected in patients complaining of hæmorrhoids.

The diffuse, infiltrating form may be easily mistaken for a luetic stricture. A syphilitic lesion tends to be a much slower process, and does not metastasize. Moreover, such lesions tend to subside under specific treatment.

When the sarcoma is polypoid, it should be possible to differentiate it from the other pedunculated tumors found in the lower rectum. Rectal adenomata are generally very soft and are found almost exclusively in children, whereas sarcomata occur in the middle aged. Rectal adenomata are often cystic on account of the continued secretion of the glands. In doubtful cases, careful examination of the pedicle will give valuable information. If the base is hard and thick, and if there is infiltration and induration of the mucosa, the lesion can be considered sarcoma; if the base moves freely with the mucosa, the lesion is unquestionably an adenoma.

The benign connective-tissue tumors are at times polypoid and are generally hard and firm in consistency. They are of much slower growth than sarcomata and are exceedingly rare.

Tuberculous lesions and sarcoma may easily be confused. The former are not nearly as rapid in growth, and there are usually evidences of tuberculosis elsewhere.

It is, however, with carcinoma that sarcoma is usually confused. It is often impossible to differentiate a non-ulcerative carcinoma from a sarcoma or an ulcerative sarcoma from a carcinoma. Nevertheless there are certain findings that should help in differentiating the epithelial and connective-tissue tumors.

Sarcoma is more lumpy and voluminous than carcinoma and seldom has an annular distribution. Considering its volume, it is more freely movable. It develops in the submucosa, obstructing the lumen by its volume, but the rectal mucosa withstands infection or ulceration for a long time and in its early stage slides freely over the mass. In carcinoma, on the contrary, the mucosa is always a part of the tumor. Carcinoma ulcerates

more quickly, starts cachexia sooner, involves the lymphatics much earlier, is almost never pigmented, and generally gives rise to more pain. Sarcoma has a pronounced tendency to invade the blood stream and metastasize to distances, such as to the lungs and liver and even to the heart muscle as recently reported by F. L. Hartmann. Sarcomata often metastasize very rapidly and are early fatal.

The diagnosis between carcinoma and sarcoma is of more academic interest as the treatment in either lesion would be the same, viz., early radical removal. The X-ray, however, possibly has different effects on the two tumors though this is doubtful when considered from the curative point of view.

CONCLUSIONS

Rectal sarcoma is a very rare lesion. Approximately 100 cases are to be found in the literature. If doubtful cases were excluded the number would be reduced one-half. The reported case is of a large spindle cell sarcoma in a man of 40, who died of a generalized sarcomatosis 7 months after the appearance of the first symptom.

The symptomatology of the ulcerative sarcomata differs but little from that of carcinoma. Carcinoma ulcerates more quickly, starts cachexia sooner, involves the lymphatics while sarcoma involves the blood stream, practically is never pigmented, and generally gives rise to more pain than sarcoma.

X-ray and radium are valueless in the treatment. An early and very radical operation is indicated because of the rapid and fatal metastasis which takes place through the blood stream.

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THE REDUCTION IN VITAL CAPACITY FOLLOWING OPERATION[1]

By EDWARD D. CHURCHILL, M.D., and DONALD McNEIL, M.D., Boston, Massachusetts

DETERMINATIONS of the vital capacity have been made on surgical patients before and after certain standard operations in order to find a quantitative expression for the crippling of the respiratory musculature which these operations entail. The vital capacity of a patient is defined as the quantity of air which can be expired after the deepest possible inspiration. The majority of the clinical studies (5) on vital capacity have been concerned with the alterations brought about by the actual encroachment upon the alveolar air space which attends certain pathological conditions of the lung and pleura, or is secondary to cardiac decompensation. We have no evidence to lead us to refer the results of the present study to any such intrapulmonary changes, and suggest on the contrary that they are chiefly referable to the immobilization of the muscles which follows an operative incision in the abdominal wall. It is obvious that the integrity of the muscles of respiration is an important factor in determining the depth of both inspiration and expiration.

METHOD OF MAKING DETERMINATIONS

The vital capacity determinations were made with a graphic spirometer; a rubber mouth-piece and a nasal clip being used. After the breathing was quiet and regular, two or more readings were made in the usual manner. In addition to the vital capacity the following facts and measurements were recorded on each patient: age, sex, height, weight, temperature, pulse-rate, blood-pressure, rate of respiration, volume per breath, total minute volume and the ratio of the length of inspiration to that of expiration.

The pre-operative determination was made with the patient in bed in the recumbent posture that was to be maintained after the operation. Following the operation a number of patients were too sick to co-operate, or suffered complications which made it necessary to exclude them from the series. A patient was never unduly urged to attempt the test, and the records which we have obtained represent in each instance a sincere attempt on the part of the individual patient to put forth his best effort. The patients who co-operated in this study were as far as could be determined clinically, free from cardio-respiratory or other disease having a known influence on vital capacity. In their post-operative course there was no clinical evidence of infection of the respiratory tract or other significant complication of convalescence during or preceding the period for which the observations are recorded.

OBSERVATIONS

As we wish to contrast the postoperative condition with that before operation we have uniformly considered the pre-operative vital capacity as 100 per cent for that patient in the presentation of results. This is done without any reference to the theoretical 100 per cent value which might be computed from body surface area. As a matter of fact, our pre-operative determinations were on the average below this theoretical value even after a deduction was made for the recumbent posture. It is possible that the disease condition for which the operation was performed played a part in this diminution of vital capacity, but our series of cases is too small to bear any particular significance in this respect.

In 1,000 routine surgical cases which he examined before operation Moersh (4) finds that diseases not affecting or influencing the respiratory or cardiac systems do not appreciably influence the vital capacity. In none of the cases included in our series was there pre-operative pain or muscle spasm which might have served to prevent free action of the respiratory muscles.

The observations fall into four groups, being classified according to the type of operation and consequently according to the site and character of the operative incision.

[1] From the West Surgical Service, Massachusetts General Hospital.

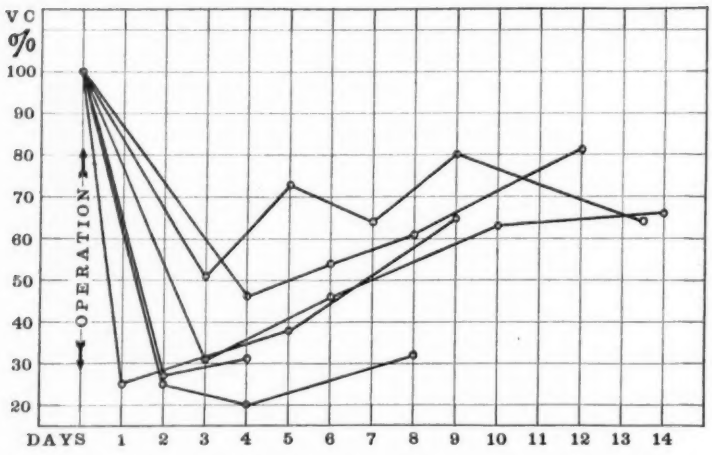

Fig. 1. Vital capacities following gall-bladder operations. Graphic expression of the determinations given in Table I, each patient being represented by a single line. The ordinates represent the vital capacity in percentage with pre-operative value considered as 100 per cent. Absissa, time in days.

I. *Right upper quadrant* (Table I; Fig. 1). The operations in these cases were all on the gall bladder or biliary ducts, and were all performed under ether anæsthesia. The incisions were vertical, splitting the fibers of the right rectus muscle longitudinally and with one exception were drained with cigarette wicks.

A graphic representation of these data is shown in Figure 1. The percentage values are calculated by using the pre-operative determination in the same patient as 100 per cent. Each line represents a single patient and the points on the line indicate the determinations of the vital capacity.

II. *Right lower quadrant* (Table II; Fig. 2). These operations were performed for the removal of the appendix in cases of chronic or interval appendicitis. The incisions were all placed below the level of the umbilicus and were carried through the rectus sheath with retraction of the muscle toward the midline. The wounds were closed without drainage and healed by first intention. The observations on this group are given in Table II and expressed graphically in Figure 2.

III. *Inguinal region* (Table III; Fig. 3). The incisions in this group of cases were placed just above and parallel to the inguinal ligament in the usual position for the repair

TABLE I.—VITAL CAPACITY DETERMINATIONS FOLLOWING GALL-BLADDER OPERATIONS

Patient	Sex	Age	Pre-operative vital capacity (c.cm.)	Postoperative vital capacity (c.cm.) Days following operation													Remarks
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	
J. S.	F	30	2070				972		1138		1283				1713			
W. W.	M	51	2670		703		807											Did not co-operate further.
A. A.	M	55	3229		807		605											Died of uræmia and terminal pneumonia on 11th day.
B. G.	F	52	1863			550			828				1138				1200	Clamp left on cystic artery 4 days.
E. N.	M	50	2040			1533		2194		1925		2503				1925		
B. S.	F	47	2152	538				807				1360						

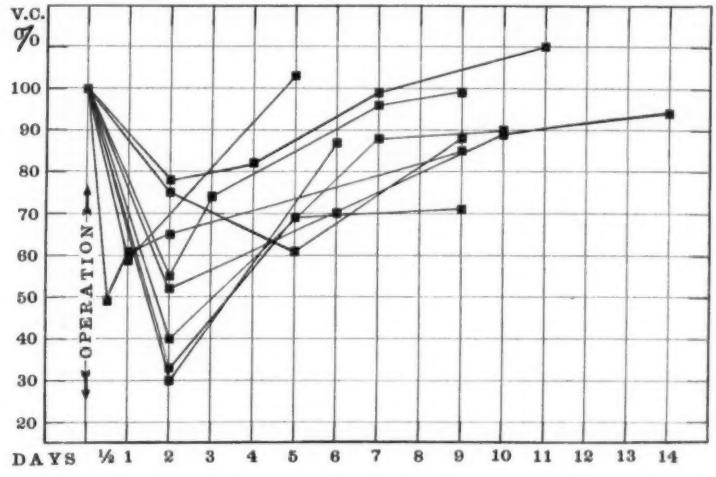

Fig. 2. Vital capacities following appendectomy operations. Graphic expression of Table 2 charted as in Figure 1.

of hernia. The repairs followed the Bassini type operation and no case is included which involved any unusual dissection or transplantation of muscles. Figure 3 shows the graphic expression of these results.

IV. *Non-abdominal operations* (Table IV). These patients were selected as control cases as the muscles in the fields of operation are not concerned with the movements of respiration. A separate graph has not been made for this group as the postoperative values are essentially the same as those obtained before operation.

SUMMARY OF OBSERVATIONS

The determinations for each group of cases are averaged to compute the curves which are combined in Figure 4. The points which determine the curve of a group are obtained by taking the average of the vital capacities of the patients observed on that day following their operation. For example, the average of eight determinations on an equal number of patients determines the point on the right lower quadrant curve for the second postoperative day. When only one patient was observed on a given day after an operation,

TABLE II.—VITAL CAPACITY DETERMINATIONS FOLLOWING APPENDECTOMY OPERATIONS

Patient	Sex	Age	Pre-operative vital capacity (c.cm.)	Postoperative vital capacity (c.cm.) Days following operation															Remarks
				½	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
A. A.	M	28	2898		1718				3000										Local anæsthesia.
A. J.	F	17	1738			517				1490									
P. S.	M	35	2877			2194		2318			2835				3129				
A. P.	F	12	1366	745	828	890							1121						
L. P.	F	24	2670			1366				1821				2318				2442	
F. F.	M	19	3415			1366					3001			2318					
G. S.	M	21	3622			2007	2691				3477		3601						
D. B.	F	13	2856			2101			1718				2484						
E. G.	M	19	3001			972			2070				2152						

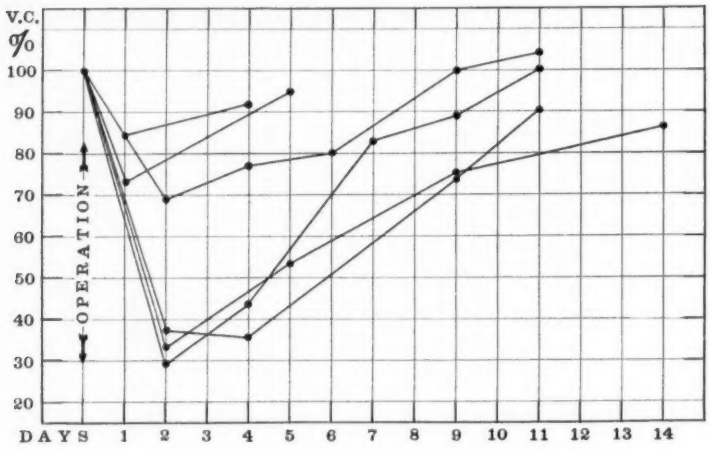

Fig. 3. Vital capacities following inguinal hernia operations. Graphic expression of Table 3 charted as in Figure 1.

that determination is taken as the point. The curves themselves were drawn free hand with an attempt to give proper evaluation to the weight of each point by taking into consideration the number of observations which it represents.

DISCUSSION

Any trauma to muscles is followed by a voluntary effort to minimize pain by non-use of the injured part; this is furthered by involuntary muscle spasm which is even more effective than the voluntary effort in maintaining a constant immobilization. The crippling of the abdominal muscles which is produced in this manner by a laparotomy incision markedly interferes with the movements of respiration, particularly those of deep and forcible expiration. The exquisite pain which attends a sudden and unguarded cough is ever remembered by one who has experienced an abdominal operation.

In our opinion this splinting of the muscles is the chief causal factor concerned in the marked reduction of vital capacity which has been observed in patients following operation, although there are certain other influences which are significant. The position and degree of inflexibility of the surgical dressing and abdominal binder are of importance. The vital capacity of a normal individual was reduced 30 per cent by the mere application of a tight dressing over the right upper quadrant and costal border with the application of a binder such as is commonly employed to hold

TABLE III.—VITAL CAPACITY DETERMINATIONS FOLLOWING INGUINAL HERNIA OPERATIONS

Patient	Sex	Age	Pre-operative vital capacity (c.cm.)	Postoperative vital capacity (c.cm.) Days following operation														Remarks
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	
J. M.	M	22	4015	2918				3808										Right inguinal hernia.
F. S.	M	43	2494		807			1345				1803					2132	Left inguinal hernia.
E. B.	M	24	4574	3850			4202											Right inguinal hernia.
T. T.	M	21	4450		1283		1925			3063		3933		4450				Right inguinal hernia. Local anæsthesia.
F. B.	M	27	4410		3063		3304		3519			4410		3630				Right inguinal hernia.
R. P.	M	26	4388		1614		1552		2173			3255		3933				Right inguinal hernia.

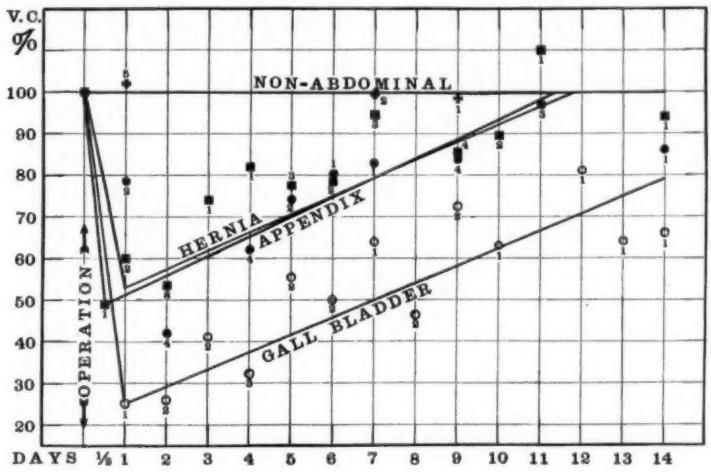

Fig. 4. Combined chart of vital capacities following operations. Method of calculation explained in text. Open circles, gall-bladder operations; closed circles, hernias; squares, appendectomies; crosses, non-abdominal cases. The small figures indicate the number of patients observed on the corresponding day after operation. Total number of patients, 26.

it in place. Other factors which undoubtedly play rôles of varying importance in different cases are sex, posture, medication depressing respiration, unusual trauma to muscles at operation, abdominal distention, fatigue, and psychic disturbances. It might be possible to evaluate these factors in a more extended study, although it is probable that their relative importance would vary in different cases.

The changes in vital capacity shown by these four groups of cases are in direct correlation with the frequency of postoperative pulmonary complications well known to exist with upper abdominal, lower abdominal, and non-abdominal operations. According to the figures of Cutler and Hunt (1) approximately 2 per cent of all patients operated on, 4 per cent of all patients who have laparotomies, and 8 per cent of all patients who have epigastric operations develop pulmonary complications.

Experimental studies conducted by Lemon (2) show that the lungs and bronchi are thoroughly drenched with secretions from the mouth and nasopharynx during a brief ether anæsthesia. Bacteria and other particulate matter inserted into the mouth of an etherized dog were subsequently recovered from the extreme periphery of the lung at autopsy.

TABLE IV.—VITAL CAPACITY DETERMINATIONS FOLLOWING NON-ABDOMINAL OPERATIONS

Patient	Sex	Age	Pre-operative vital capacity (c.cm.)	Postoperative vital capacity (c.cm.) Days following operation									Remarks
				1	2	3	4	5	6	7	8	9	
A. C.	M	46	2421	2401						2453		2318	Varicose veins, left leg.
S. G.	M	20	3829	3829									Fistula *in ano*.
M. R.	M	14	2339	2339									Tuberculous cervical lymph nodes.
J. B.	M	42	3105	3208						3063			Fistula *in ano*.
D. M.	M	47	4140	4636									Neurolysis of ulnar nerve.

The limitation of respiratory excursion which we have demonstrated in postoperative patients would seem to favor the retention of the bacteria laden secretions instead of permitting their normal rapid expulsion by deep breathing and coughing. The retention of these secretions might then prove to be a causal factor in the development of the postoperative pneumonitis characterized by a transient rise in temperature and the production of a thick purulent sputum during the early days of convalescence.

The marked reduction in vital capacity following laparotomy has an explanatory bearing on the observations of Lemon and Moersch (3) which serve to correlate an increased operative risk with a low pre-operative vital capacity reading. If it is realized that an operation involving the muscles of the abdominal wall temporarily leaves the patient with but 25 to 50 per cent of his pre-operative vital capacity, it is readily understandable that a patient with an initial reading which approaches the tidal air requirement will be subjected to a grave risk by such a procedure.

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PATHOGENESIS OF JAUNDICE[1]

By CHARLES GORDON HEYD, B.A., M.D., F.A.C.S., New York
Professor of Surgery, New York Post-Graduate Medical School and Hospital

JOHN A. KILLIAN, M.A., Ph.D., New York
Professor of Biochemistry, New York Post-Graduate Medical School and Hospital

PAUL KLEMPERER, M.D., New York
Associate Professor of Pathology, New York Post-Graduate Medical School and Hospital

OUR conception of jaundice has undergone many changes and recently a fundamental revision. In 1847, Virchow upon finding hæmatoidin crystals in connection with fluid collections of blood postulated the development of jaundice from causes that arose within the liver and, in addition, a jaundice that arose from pathological processes outside of the liver. This view was held, more or less intermittently, throughout the subsequent period although it was largely invalidated by the celebrated experiments of Minkowski and Naunym (12) carried out on geese the livers of which had been removed and in which despite the severest degree of arsenhydrogen poisoning no jaundice occurred. In the light of these experiments it was asserted that "without the liver no formation of bile—without the liver, no jaundice." Thus the only type of jaundice that could be recognized was that of hepatogenous origin, it being considered that true hæmatogenous icterus was not possible.

The experiments of Whipple and Hooper (19), Mann (7, 8) and his colleagues, and McNee (10), have invalidated the findings of Minkowski and Naunym. Fundamentally, the pathogenesis of jaundice involves a decision as to whether bile pigment is formed within or without the liver cells.

Jaundice has heretofore been confined almost entirely to the recognition of tissue icterus, which is essentially a clinical designation and gives a very imperfect picture of the underlying chemical mechanism. Jaundice is the result of the accumulation of bilirubin in the blood stream. There is a normal bilirubin content in the blood at all times. This may be termed physiological bilirubin and represents approximately 1 part of bilirubin to 400,000–600,000 parts of blood serum (17). The blood content of bilirubin may be raised to 1 in 40,000 before macroscopic tingeing or tissue jaundice occurs. There is thus a blood icterus which ranges from the normal blood bilirubin content up to a bilirubinæmia of 1 in 40,000 before clinical jaundice is apparent. This bilirubin range is termed latent jaundice —an icterus of the blood serum and detected only by chemical tests. It is obvious that a blood icterus always anticipates a clinical icterus. This chemical blood condition is analogous to that which is present in diabetes with blood sugar and in nephritis with blood urea. In a chemical sense jaundice is essentially a disorder of bilirubin metabolism and always manifests itself by an accumulation of bilirubin above the normal physiological blood content.

A broad consideration of the pathogenesis of jaundice will embrace (1) the metabolism of hæmoglobin; (2) the chemistry of bilirubin; (3) the site of formation of bilirubin; (4) its physiological purpose in the organism; (5) the normal and pathological basis for its elimination, retention and accumulation; (6) the various viscera concerned in its disposal or elimination; (7) the effects of bilirubinæmia; and finally its chemical detection and identification. Theoretically, we may suppose that jaundice occurs (1) as the result of intrahepatic or extrahepatic obstruction of the biliary passages; (2) as the result of degeneration or dysfunction of hepatic cells; or (3) as the result of an excessive production of bilirubin by the reticulo-endothelial cell system, particularly the reticular cells of the spleen and Kupffer cells of the liver. Bilirubin may be formed by the cells of the reticulo-endothelial system without any activity upon the part of the liver parenchyma. Bile salts, however, are the specific product of the liver

[1] Read before the American Gastro-Enterological Association, Atlantic City, New Jersey, May 4, 1926.

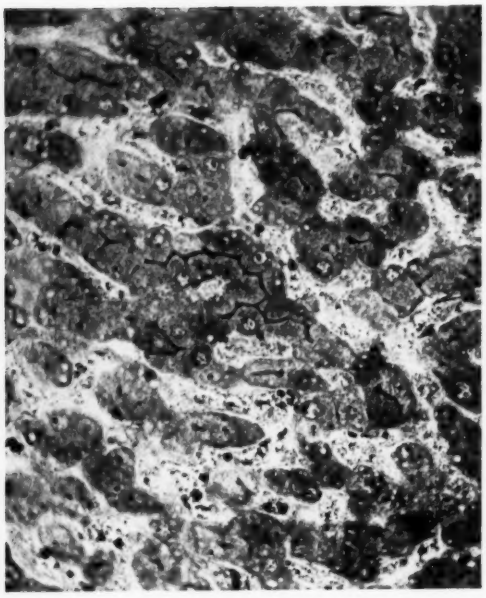

Fig. 1. Showing normal intercellular and intracellular bile capillaries. Note the smooth even lumen of the bile capillaries.

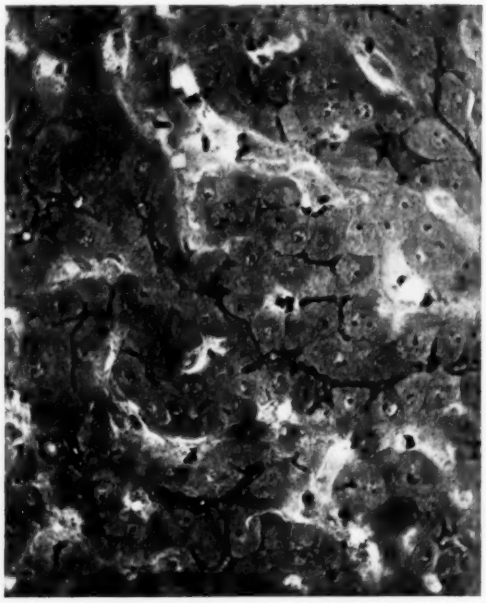

Fig. 2. Showing intercellular and intracellular bile capillaries in obstructive jaundice. Note tortuous, distended varicose bile capillaries with rupture and "laking" of bile.

parenchyma and the production of bilirubin together with bile salts is a function limited to the liver and by no other organ can these two chemical moieties be simultaneously produced. Furthermore, no other viscera can assume vicariously their simultaneous and combined elaboration. The finding of bile pigments in the tissues and body fluids in association with bile salts would obviously point to an accumulation of bilirubin as the result of the absorption of bile that had already passed through the polygonal liver cells or was in the process of passing through them. The origin of such a jaundice would be due either to an obstructive mechanism—mechanical jaundice—or to a dysfunction of the liver cells with or without obstruction—functional jaundice. These two types being essentially hepatic forms of jaundice it follows therefore that the presence of bilirubin in the tissues and body fluids but without the presence of bile salts, a dissociated jaundice, would point to a pure pigmentary accumulation, a bilirubinæmia. This form of jaundice is the result of the activity of the reticulo-endothelial cell system—spleen and Kupffer's cells of the liver. It is therefore necessary to distinguish two entirely different types of jaundice: (a) a jaundice due to bilirubin plus bile salts and (b) a jaundice due to bilirubin *per se*.

The amount of bilirubin in the bile is an accurate index as to the amount of blood destruction for the coloring matter in bile pigment is derived only from the blood (3, 14). It may be assumed that, so far as the liver is concerned in the formation of bile pigment, there are three possibilities (1): (1) the liver cells are excretory only for bile pigments—a sort of passive excretion in which they do not functionally participate; (2) the liver cells alter bilirubin during excretion (4, 11); (3) the liver cells elaborate bilirubin from hæmoglobin.

Van den Bergh (17) assumed that icterus was entirely due to an increase of bilirubin in the serum, and upon utilizing the color reaction giving by bilirubin with the diazo reagent of Ehrlich he was able to make the original

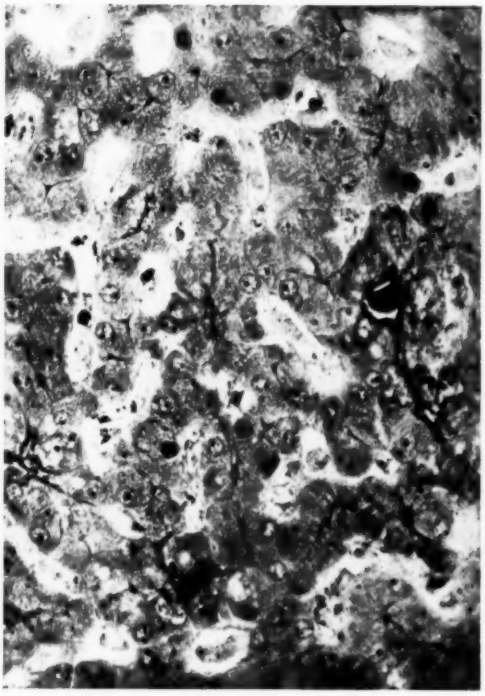

Fig. 3. Showing "laking" of bile in obstructive jaundice with rupture of bile capillary and extravasation of bile.

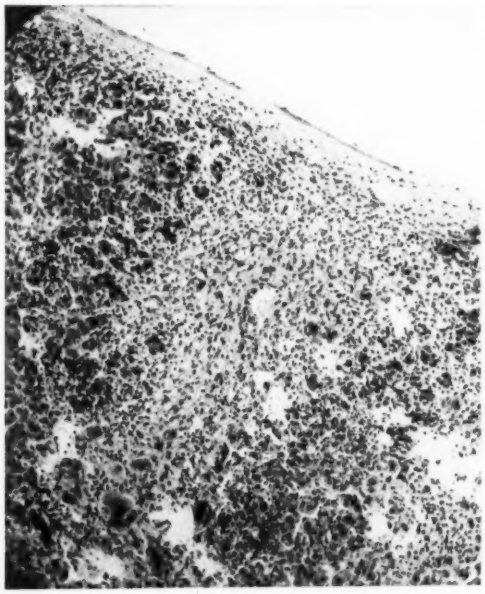

Fig. 4. Showing necrosis surrounding the central vein for about one-third of the diameter of the lobule. Specimen obtained from small portion of liver removed during operation. Case of hæmatohepatogenous jaundice, supposedly acute catarrhal jaundice.

observation that in some cases of jaundice it was necessary to bring the bilirubin into alcoholic solution before a color reaction could be obtained, while in other cases the adding of the icteric serum directly to the diazo reagent brought about a color reaction. He, therefore, made the very important distinction that in the icteric group there were two distinct kinds of sera: first, sera which gave a color reaction at once or immediately upon the addition of diazo reagent directly to the sera, the so-called prompt or immediate reaction; secondly, sera which gave no color reaction, or only after a long delay on the addition of the diazo reagent directly to the sera, the so-called delayed reaction. Van den Bergh supposed that a prompt direct reaction was obtained only from a bilirubin that had passed through the polygonal liver cells and had subsequently been absorbed because of obstruction. On the other hand, if the sera gave a delayed reaction he assumed that the bilirubin had been formed independently of the liver cells and in addition had not passed through them. If this thesis be correct then there are two kinds of bilirubin to be found in cases of jaundice. That this contention is supported by clinical facts is evidenced by the following: (1) bile from the gall bladder always gives a typical prompt direct reaction—this bile has obviously passed through the liver; (2) bilirubin obtained from the serous fluids, in hæmorrhagic effusions in the chest or abdomen, or knee joints, gives the delayed reaction only, or generally not at all. Such a bile pigment has been elaborated independently of the polygonal cells of the liver.

Experiments by Kodama[1] on dogs showed that as long as the icteric serum gave a delayed reaction, the liver cells were entirely unaltered. The Kupffer cells on the contrary showed marked swelling and infiltration with a yellow pigment. This delayed reaction is

[1] Quoted by Aschoff (1).

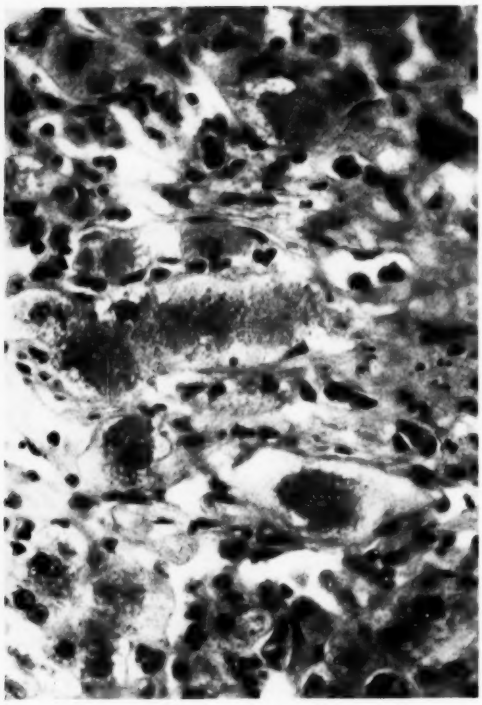

Fig. 5. Same case as in Figure 4. Hæmatohepatogenous jaundice, supposedly acute catarrhal jaundice. Note some of liver cells with apparently normal nuclei and marked granular degeneration and necrosis. In some places complete cellular necrosis.

Fig. 6. Same case as in Figures 4 and 5. The bile capillary is destroyed because the surrounding liver cells which support or hold the bile capillary intact are undergoing degeneration. Note some nuclei are still visible, other nuclei are undergoing karyolysis, others have disappeared. Note "laking" of bile and droplets of bile passing through the cellular detritus of the liver cell.

not due to a dysfunction of the liver cells because the bile capillaries are filled with bile of altered consistency and increased quantity, a hyperfunction of liver cells rather than dysfunction. According to Aschoff (1) the appearance of a prompt bilirubin reaction was simultaneous with the formation of bile thrombi, bile capillary obstruction. These bile thrombi are formed simultaneously with the excretion of a thick tenacious bilirubin. If the reticulo-endothelial cell system is paralyzed (Lepehne) this tenacious bilirubin is not produced and cannot be secreted by the liver cells and there are no bile thrombi and no stasis icterus.

Histological study of liver sections showed that the prompt direct reaction occurs only when there is evidence of blocking of the bile capillaries with obvious bile cylinders or bile thrombi. Therefore, bilirubin in the blood in icterus has only two sources: (1) from a retention and accumulation of bile pigment which gives a delayed reaction, or (2) from the reabsorption from the bile passages after an obstruction which gives a direct reaction.

It is the cells in the reticulo-endothelial cell system, and particularly Kupffer's cells in the liver and the reticular cells of the spleen, which are concerned with the breaking down of hæmoglobin into bilirubin. Bile pigment, hæmosiderin and fragments of red corpuscles have been seen repeatedly in both these types of cell, but particularly in Kupffer's cells of the liver. It would seem then that splenic

tissue, without and within the liver (Kupffer's cells), and not the liver cells *per se* plays a very prominent part in the formation of bile pigment. On the other hand, not the slightest proof has been brought forward to substantiate the hepato-cellular formation of bile pigment (1). Jaundice may then arise theoretically from the obstruction of the outlet of the bile capillaries after the changed bilirubin has passed through the polygonal cells of the liver, or it may occur by reason of the fact that the bilirubin has not passed through the polygonal cells but is absorbed by the vascular capillaries or lymphatics of the liver into the general circulation. The former would be the elimination of an altered bilirubin with bile salts and subsequent absorption from obstruction; the second would be the absorption of an unaltered bile pigment and without bile salts. It is this conception of jaundice that explains the two reactions of van den Bergh's test. It seems possible therefore to predicate inferentially two different kinds of bilirubin. While these have not been experimentally or clinically demonstrated, the behavior of bilirubin in varied conditions of jaundice allows this assumption. It would seem that there is a normal content of bilirubin that at all times is circulating in the body. A portion of this bilirubin, which we may call bilirubin A′, is taken out by the activity of the liver cells and eliminated in the bile. This bilirubin is possibly of no use to the organism and represents a waste product in the process of excretion, for by its concentration or by some slight change in its chemical character, it gives the positive direct reaction of van den Bergh. The remaining moiety of bilirubin is evidently a useful product conserved by the organism and so is not withdrawn from the blood stream by the liver cells and continues circulating. This type of bilirubin A is dissimilar either in concentration or in slight variation of chemistry from the other and gives ordinarily the indirect reaction of van den Bergh. It is apparently this type of bilirubin that reaches a large measure of concentration in pathological hæmolysis and gives the distinct bilirubinæmia of hæmolytic jaundice. The amount of bilirubin in hæmolytic jaundice available for action upon by the liver cells is greatly in excess

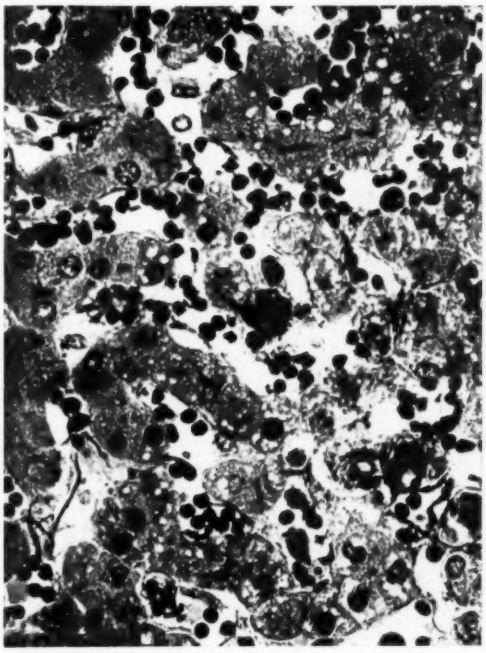

Fig. 7. Jaundice in pneumonia. Showing distended bile capillary with "laking" of bile.

of their capacity and there might be a direct injury to the liver cells by reason of the overcharged bilirubin content. The presence of calculi in hæmolytic jaundice in non-inflammatory gall bladders and ducts would suggest that this element of pleiochroma was a factor in their production. The removal of the spleen would obviously limit the degree of pathological hæmolysis and the liver would then be able to excrete its normal quantity of bilirubin. The liver has a threshold for the elimination of bilirubin just as has the kidney. In some cases it allows the elimination of bilirubin in the bile much more readily than in others, and in hæmolytic jaundice the threshold is exceedingly high with retention and accumulation of bilirubin in the blood stream. The bilirubin that occurs in frank obstructive jaundice or in disease of the liver cells has a renal threshold of 1 in 40,000, whereas the bilirubin that occurs after marked hæmolysis and meets its best example in hæmolytic jaundice has a much higher threshold of renal

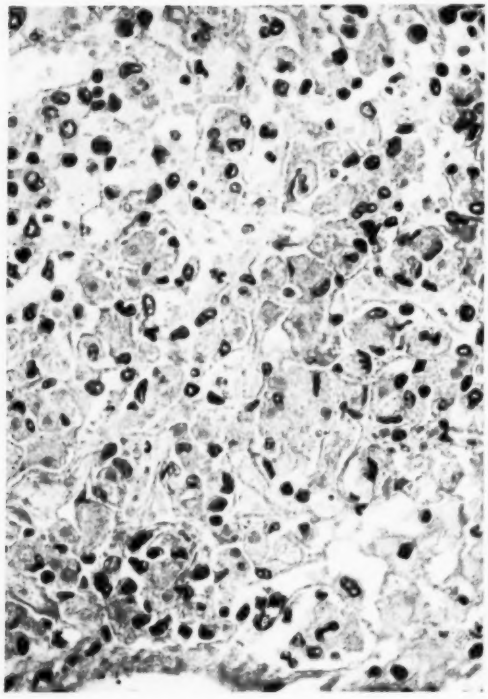

Fig. 8. Jaundice in pneumonia. Note the necrosis of the hepatic cell. In places nuclei still visible; in other portions nuclei have disappeared with atrophy of the cell.

Fig. 9. Photomicrograph made in a case of icterus neonatorum, showing bile thrombi. Note drop of bile outside of liver cells.

elimination and does not appear in the urine as a bilirubinuria. In fact it may be doubted if in hæmolytic jaundice, without some added complication, bilirubin ever passes through the kidney at all (10). In McNee's own cases in which 11 units of bilirubin were present in the serum, not a trace of bilirubinuria was observed.

A certain amount of bilirubin is always present in normal serum. It is referred to in the literature as functional bilirubin. It apparently embraces limits from 1 in 1,000,000 to 1 in 400,000, and van den Bergh has taken as a unit of bilirubin the figure 1 in 200,000. Macroscopic jaundice appears in the tissues at approximately the point that bilirubin is eliminated by the kidney, namely, 1 in 40,000, and this range between 1 in 80,000 and 1 in 40,000 has been defined as latent or blood icterus. Greene and Aldrich modified van den Bergh's method, producing a practical quantitative determination of the bilirubin in the blood serum. The bilirubin is determined colorimetrically as azobilirubin in milligrams per 100 cubic centimeters of serum. These authors state that the normal concentration of azobilirubin in the blood serum may be from 0.5 to 2 milligrams per 100 cubic centimeters. Although we have found this method not always satisfactory for quantities of bilirubin less than 3 milligrams per 100 cubic centimeters, this procedure has proven of immense value for hyperbilirubinæmia. When the icterus index exceeds 10, the azobilirubin has been found to be above 2 milligrams per 100 cubic centimeters. In hyperbilirubinæmia, there is a parallel rise in the icterus index and the azobilirubin of the blood serum.

The intensity of jaundice is best obtained by a determination of the icterus index of the

blood serum by the method proposed by Stetten (16). The icterus index is the measure of intensity of the color of the blood serum as compared with the standard which is 1 to 10,000 solution of potassium bichromate. Normally, the blood serum is three to six times as intense in color as the standard. So the normal icterus index is from three to six. With latent jaundice, the icterus index may rise as high as fifteen. The clinical evidences of jaundice are usually obtained when the icterus index has risen to 25 to 30. This is a test for the quantitative degree of icterus but gives no information as to the character of the pigments or as to whether it is an obstructive, toxic, or dissociated type of jaundice. It is a measure only of the degree of jaundice. It is necessary to combine this test with van den Bergh's, for the latter indicates in a measure the type of icterus which is present.

We have not made a study of the bile salts in the serum, and while we have done some work with the bile salts in the urine we are not prepared at this time to make any comment thereon. We have, however, utilized changes in the cholesterol content in the blood stream as a means of distinction between obstructive jaundice and other types of jaundice. We found that in obstructive jaundice there is a rise in the cholesterol content in the blood which usually keeps pace with the changes in the bilirubin, but in non-obstructive jaundice the cholesterol is not increased and in the jaundice associated with anæmias the cholesterol is significantly decreased. Several cases of pernicious anæmia showed icterus but no increase in cholesterol. Cases of obstructive jaundice showed marked icterus and an increase of the blood cholesterol. The low cholesterol in the cases of pernicious anæmia is worthy of note from the known power that cholesterol has as an antihæmolytic agent or as a protection against blood cell destruction.

Up to date there has been no work that enables us to determine the place occupied by bile salts. It is of interest, however, to recall that the threshold for elimination of bile salts is almost nil, and they are eliminated by the kidneys almost immediately. We have, however, clinical evidence that there are symptoms occasionally present, such as bradycardia, pruritis, which are due to the loss of bile salts before the renal threshold for bilirubin is reached and therefore before there is clinical evidence of icterus. While there has been no positive proof adduced as to the absolute verity of the two types of bilirubin, the results obtained from van den Bergh's test certainly suggest such a distinction and according to McNee (11) we may classify jaundice into three main types: (1) obstructive hepatic jaundice; (2) toxic and infectious hepatic jaundice, and (3) hæmolytic non-hepatic jaundice (Chart I). Obstructive hepatic jaundice presupposes a normal bile formation and a normal mechanism of excretion through apparently normal liver cells. This mechanism does not obtain for any great length of time after obstruction has occurred, for normal bile is no longer secreted nor are the liver cells intact. We may have, however, a jaundice that in the beginning at least is purely obstructive. That the mechanical factor of obstruction does not long obtain is evident for just as soon as the obstruction raises the hydrostatic pressure of the fluid within the ducts to a degree equal to that of

CHART I.—JAUNDICE

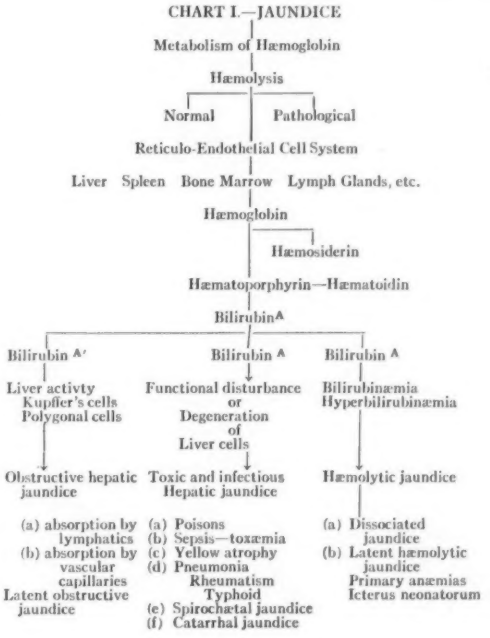

TABLE I.—BILIRUBIN IN BLOOD AND UROBILIN IN URINE IN OBSTRUCTIVE JAUNDICE

Case Sex Age	Date	Icterus Index	Blood Analyses				Urine Urobilin	Remarks
			Van den Bergh		Azobilirubin	Cholesterol		
			Direct	Indirect	Mgm. per 100 c.cm.	Mgm. per 100 c.cm.	Mgm. per 100 c.cm.	
1. M.R. 48	9–22–25	116	+++	+++			Negative	Carcinoma of pancreas.
	10– 6–25	192	++++	++++		315	Negative	Stools clay-colored.
	10–15–25	165	++++					
	10–21–25	150	++++	++++		480	Faint trace	Stools clay-colored.
2. A.M. F. ?	3–13–25	110	+++	+++		210	Trace	Carcinoma of gall bladder with metastases to liver.
	3–22–25	150	+++	+++		214	Negative	
3. J.G. M. 67	9–14–25	174	++++	++++			Negative	Chronic pancreatitis.
	9–23–25	182	++++	++++			Negative	
	9–28–25	144	+++	+++				Stools clay-colored.
	10– 2–25	108	+++	+++		156		
	10– 7–25	95	++	++			Trace	
	10–15–25	56	++	++			40	Stools pigmented.
	10–21–25	47	++	++			Negative	
	10–26–25	36	+	+			Negative	
4. J.B. M. 45	10– 2–25	127	+++	+++		648		Chronic cholecystitis and pancreatitis.
5. J.S. F. 55	3–18–26	41	+		4.4		11	Chronic cholecystitis.
6. M.R.	3–24–26	150	+++	+++			Trace	Carcinoma of gall bladder, metastases to liver.
	3–30–26	225	++++	++++	31		6	
	4– 5–26	165	++++	++++	25		Trace	
	4–10–26	166						3–29, Stools faintly pigmented.
	4–16–26	216	++++	++++	27		Negative	

TABLE I. The icterus index of the blood serum has been determined by the method described by Stettin and Bernheim. McMaster's procedure for urobilin has been utilized and Greene, Snell, and Walters' modification of the van den Bergh technique for azobilirubin. The cholesterol was determined by the method of Myers and Wardell. Previous to the introduction of a dependable quantitative method by McMaster, the alcoholic zinc chloride procedure of Wirsung, or the iodine technique of Gerhardt were used for the detection of urobilin.

In the group of cases reported in this table, the hyperbilirubinæmia is indicated by a marked increase in the icterus index of the blood serum. Both direct and indirect van den Bergh reactions are positive. Greene, Snell, and Walters state that the normal concentration of azobilirubin in blood serum is from 0.5 to 2 milligrams per 100 cubic centimeters. Where determined the azobilirubin is increased from 4 to 30 times the normal. There is observed a definite hypercholesterolæmia. The urobilin is negative or excreted in minute amounts. The absence of urobilin from the urine indicates a failure to deliver bilirubin into the intestinal tract. When, as in Case 6, the obstruction to bile output becomes more complete the urobilin in the urine decreases to a negative reaction. However, in Case 3 the obstruction is temporary, and when it is relieved, urobilin appears in the urine signifying a delivery of some bilirubin into the intestines. The appearance of urobilin here would also indicate an impaired liver function consequent to the obstruction. It is interesting to note that traces of urobilin are sometimes observed in cases with all other evidence of complete obstruction. This observation is in keeping with McMaster's findings on dogs and no doubt a similar explanation is warranted. In dogs, McMaster found at autopsy the intestinal mucosa stained with bilirubin, evidently secreted there from the systemic circulation. From the bilirubin in complete obstruction urobilin was formed.

the secretory liver pressure there must of necessity be a cessation of flow or even a reversal of direction of the bile current with a functional or intrinsic damage to the liver cells. We know, however, that the entire right lobe of the liver can be put out of business by blocking of the right hepatic duct without exhibiting jaundice (6) or any clinical manifestations of impaired liver function. The liver is essentially a silent organ, provided some portion of it is allowed to exercise its normal function. There may be an impairment of a considerable portion of the hepatic parenchyma in one or many of its functions

TABLE II.—BILE PIGMENTS IN THE BLOOD AND UROBILIN IN URINE IN ANÆMIA AND CATARRHAL JAUNDICE

Case Sex Age	Date	Icterus Index	Blood Analyses				Urine Urobilin	Remarks
			Van den Bergh		Azobilirubin	Cholesterol		
			Direct	Indirect	Mgm. per 100 c.cm.	Mgm. per 100 c.cm.	Mgm. per 100 c.cm.	
1. S.E. F. 19	12–14–25 12–22–25 12–29–25 1– 8–26	100 65 35 15	+++ ++ +	+++ ++ ++	 1.54	98	1890 12 Neg.	Purpura hæmorrhagica. R.B.C. = 1,684 million. Transfusion 12–22. 12–24 R.B.C. = 2,288 million. 1–8–26 R.B.C. = 2,504 million.
2. H.A. M. 74	8– 4–24	15	−	+			+	Pernicious anæmia.
3. B.K. F. 52	2–27–25 3– 2–25 3–10–25 3–18–25 3–26–25 4–29–25	225 220 80 52 35 11	++++ ++++ ++ ++ − −	++++ ++++ ++ ++ + +		160 166	+++ +++ ++ Neg. Neg.	Catarrhal jaundice.
4. H.M.	12– 5–24	151	+++	+++			+++	Catarrhal jaundice.
5. M.J. F. 35	1–11–26 2–24–26	46 37	+++ −	+++ +	7.3 3.9		148 94	Catarrhal jaundice.
6. E.C. F. 29	2– 3–26	44			5.6		378	Obstructive jaundice (?).

TABLE II. The hyperbilirubinæmia is indicated by an increased icterus index. At the height of the hyperbilirubinæmia, both direct and indirect van den Bergh reactions are positive, but with the diminishing jaundice the direct reaction first becomes negative, a positive reaction with the indirect method persisting usually until the icterus index drops below 10. In Case 2, an icterus index of 15, with a positive indirect van den Bergh reaction were noted without clinical evidence of jaundice. No increase is noted in the blood cholesterol. In Case 1 a subnormal cholesterol was found. A marked increased output of urobilin in these cases accompanies the icterus. Case 6 was diagnosed on admission as an obstructive jaundice. However, during a period of 20 days, during which time nothing had been done for the patient surgically, the jaundice diminished. The findings reported in the table were obtained on admission, but after the height of the icterus had been reached. The increase in the serum icterus with the marked output of urobilin, we believe, would indicate a catarrhal rather than an obstructive jaundice.

and yet there may be preserved sufficient intact liver to carry on and functionate without jaundice.

The French school, with which is associated the names of Brulé (10), Chauffard, Gilbert, and Widal, are in a large measure responsible for the introduction of the conception of dissociated jaundice as well as laying emphasis upon the importance of functional derangement of the hepatic cells which leads directly to a variety of degenerative processes within the liver parenchyma. It is more than probable that acute catarrhal jaundice, jaundice of pneumonia, of acute articular rheumatism, of sepsis, or a jaundice that occurs with pronounced toxic conditions or poisonings, is of a systemic nature and induces functional or organic change in the liver cells. Under toxic and infectious hepatic jaundice we must include icterus in (1) poisoning, (2) sepsis, (3) acute yellow atrophy, (4) pneumonia, acute rheumatic fever, typhoid fever, etc., (5) spirochætal icterus and (6) catarrhal jaundice. The mechanism of this group of jaundice is essentially and primarily that of functional and organic injury to the liver parenchyma. Brulé is inclined to believe that infection of the bile ducts inevitably induces a change in the liver cells. From our studies in cases of catarrhal jaundice, it would seem that this type of jaundice is an hæmatohepatogenous infection or toxæmia charac-

TABLE III.—BILIRUBIN IN BLOOD AND UROBILIN IN URINE IN LIVER DISEASE

Case Sex Age	Date	Icterus Index	Blood Analyses				Urine Urobilin	Remarks
			Van den Bergh		AzobiErubin	Cholesterol		
			Direct	Indirect	Mgm. per 100 c.cm.	Mgm. per 100 c.c n.		
1. R.Y. M. 29	8-14-24 9-6-24 10-13-24	11 30 45	 0 ++	+ + ++		 195	 + +	Hypertrophic cirrhosis of liver.
2. J.C. M. 66	10-27-24	7.5	0	+			+	Cirrhosis of liver.
3. M.E. M. 27	10-21-24 11-4-24	98 58	+++ +++	+++ +++			+ +	Post-arsphenamine hepatitis.
4. J.A. F. 30	12-12-24	13	0	+		282	+	Lues. nephrosis.
5. C.L. F. 30	2-25-26 3-3-26	60 60	+++ +++	+++ +++		145 144	 376	Luetic hepatitis.
6. C.O. F. 5	10-21-25	39	+	++++			−	Fatal phosphorus poisoning.
7. J.M. M. 33		130	+++	+++		160	+	Acute yellow atrophy.
8. V.C. F. 19 days		187	+++	+++				Icterus neonatorum.
9. S.Z. F. 17	9-23-24	13	−	+		139	+	Chronic cardio-valvular disease — decompensated.

TABLE III. In cases with evident damage to liver function, but no evidence of biliary obstruction, an increase in the serum icterus index is noted, the rise, however, is not so great as in the cases showing obstruction. When the icterus index is less than 15, only an indirect positive van den Bergh reaction is obtained, the direct remaining negative. However, in the more pronounced cases of icterus, both reactions were found to be positive. All of the analyses for urobilin, except Case 5, were made before the introduction of McMaster's method. We have to depend solely upon qualitative tests. All of these cases, except 6, gave positive reactions for urobilin. In Case 6, there was persistent vomiting for about 24 hours before death, and at postmortem extensive hæmorrhages throughout the gastro-intestinal tract were found. These factors may have influenced the passage of bilirubin into the large intestines, or the production of urobilin. Normal figures for cholesterol are noted, except in Case 4, J. A., female, 30 years of age; in this case the nephrosis is responsible for the high blood cholesterol.

terized primarily by injury to the liver parenchyma. In our liver sections of catarrhal jaundice, we have an almost complete necrosis leading to atrophy about the central vein. Some of the liver cells show marked granular degeneration. The bile capillaries are destroyed because the surrounding liver cells are undergoing cytolysis and chromatolysis, "laking" of bile occurs with droplets of bile passing through degenerated liver cells.

The first effect of jaundice will be apparent in the liver. In obstructive jaundice there is marked distention of all the bile passages. The intrahepatic bile capillaries are dilated and tortuous, "laking" of bile occurs with rupture of the bile capillaries. There is marked œdema and swelling of the liver as a whole. Cases are recorded in which over one liter of bile had accumulated in them (13, 19). The liver cells continue to secrete for a time but

are soon injured by the chemical effect of bile and pressure. The ability to store glycogen is soon lost, and the excretion of bile acids decreases. Histological examination of liver sections in toxic or infectious jaundice shows parenchymatous changes from simple cloudy swelling as in pneumonia and acute articular rheumatism, to granular degeneration and necrosis in some cases of catarrhal jaundice, to fatty degeneration as in chloroform poisoning, to partial necrosis and vacuolization in spirochætal icterus, up to complete and total necrosis in acute yellow atrophy. If the offending agent is not sufficiently grave nor too long continued, the liver injury may be healed clinically by a process of fibrous tissue replacement.

A consideration of the third group of hæmolytic jaundice leaves many points unsettled. One recalls that in the icterus of hæmolytic jaundice the removal of the spleen is followed by a disappearance of the jaundice and also by a loss in the fragility of the erythrocytes. Manifestly in this condition we have a marked hæmolysis constantly taking place. In lesser degree the same factors exist in the primary anæmias as opposed to the secondary anæmias. The presence of normally colored stool in hæmolytic jaundice is proof that the mechanical factor is not one of great prominence, for sufficient bile is always delivered into the intestine.

Pernicious anæmia is a type of latent hæmolytic jaundice. The bilirubin content is increased to five to six units. This type of latent hæmolytic jaundice is also a constant feature in the serum of all newborn children exhibiting icterus neonatorum. Likewise splenic anæmia or Banti's syndrome can be included in the above classification of hæmolytic jaundice. So frequently has this association of jaundice with pathology in the spleen and liver been found that Eppinger has designated these conditions as "liver-spleen diseases" (5).

In connection with the consideration of jaundice it is interesting to canvass what has been described as the enterohepatic circulation of bile pigments (2). When bile is delivered into the intestinal tract the bilirubin is converted into hydrobilirubin. The latter,

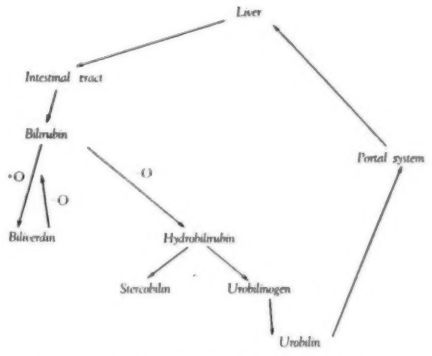

Chart 2. Enterohepatic circulation of bile pigments.

by the activity of intestinal bacteria, is changed into stercobilin and urobilin. The urobilin is in a large measure reabsorbed by the intestinal veins of the portal system and delivered to the liver cells. Some of this urobilin is excreted with the bile so that we have a constant urobilin cycle or an hepato-enterohepatic circulation (Chart 2). Under normal conditions no urobilin can be determined in the urine. When urobilin reaches 1 milligram in 100 cubic centimeters, or 1 in 100,000, it may be detected in the urine by adequate tests. For a normal enterohepatic circulation it is necessary to have intact liver cells, for in the presence of normal liver cells the urobilin does not get into the systemic circulation. It is obvious that in the presence of complete obstructive jaundice there can be no reabsorption of urobilin from the intestine and hence urobilin will not appear in the urine. If, however, there is an incomplete obstruction which will permit of the delivery of some bile into the intestinal tract, then the presence of any slight degree of functional disturbance of the liver cells will permit urobilin being delivered into the systemic circulation and its subsequent appearance in the urine. If the liver cells are injured, however, with or without obstruction, there is a delivery of urobilin into the systemic circulation. MacMaster and Rous have drawn attention to minute quantities of urobilin that may be found even in the presence of complete obstruction. The mechanism for this presupposes that in conditions of chronic icterus there is an elimination

of bilirubin into the intestinal tract by the systemic circulation, and this bilirubin is changed to urobilin and is reabsorbed by the portal system, and, in the presence of injury to the liver cells, is delivered into the blood stream and later appears in the urine.

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SPLANCHNIC ANÆSTHESIA

A Critical Review of the Theory and Practice of This Method

By GEZA DE TAKATS, M.D., M.S., Chicago
Associate in Surgery, Northwestern University Medical School

SPLANCHNIC anæsthesia was first induced in man by Kappis. He not only described a technique of approach but is responsible for a theoretical basis gained by animal experimentation. Kappis made his first report in 1914 at the Surgical Congress in Berlin. Previously, Neumann had shown at the Physiological Institute of Vienna (1910–1912) that the splanchnics are the sensory nerves in the frog and the dog for upper abdominal organs. Neumann and Kappis then introduced independently from each other this new idea of anæsthetizing abdominal organs. Kappis published the first detailed report of 200 cases in 1918. Following his communication, many reports appeared of the use of the original technique or slight modifications of it. In the same year Wendling suggested an approach through the closed anterior abdominal wall. This idea was carried further by Braun, who in 1919 reported through Buhre the approach to splanchnic nerves and cœliac plexus through the open abdomen. As Wendling's method was not followed by anyone, there remain the two methods of approach; that of Kappis from behind, and that of Braun from the front.

In English speaking countries Labat's technique is usually taken to mean the posterior route. Credit is due to Labat for having introduced splanchnic anæsthesia by an article in the *British Journal of Surgery* in 1921. He modified the angle of approach and made a detailed anatomical study of this subject. However, he is not responsible for the theoretical basis, which Neumann and Kappis have furnished.

In the French literature, Roussiel claims priority over Pauchet and Labat, having started his experiments in 1917 and published the first cases in 1919. He calls the method paravertebral but uses exactly the same approach as Kappis.

It is better to avoid authors' names in medical nomenclature, therefore the terms posterior splanchnic anæsthesia and anterior splanchnic anæsthesia seem to me more advisable.

The theoretical importance of splanchnic anæsthesia is that our conception of the sensory innervation of abdominal organs has had to be revised.

ANATOMICAL CONSIDERATIONS

The great splanchnic nerve is usually formed by branches from the sixth, seventh, eighth, and ninth thoracic ganglia of the sympathetic trunk. Occasionally a fiber may be added from the fifth or tenth ganglion. It is thick as a match and runs down on two sides of the vertebral column, passes the diaphragm between the medial and intermedial crura on the right side with the azygos, on the left with the hemiazygos vein. The nerve enters the abdominal cavity at the height of the twelfth rib where this crosses the scapular line, between the first and second lumbar vertebræ. After a short straight course the nerve bends at an approximately right angle toward the midline and joins the upper end of the cœliac plexus (Fig. 1).

The lesser splanchnic nerve originates with two branches from the tenth and eleventh thoracic ganglia, occasionally with a fiber from the twelfth ganglion. The course is similar to that of the great splanchnic nerve, with which it runs parallel but on a somewhat more dorsal plane. It joins partly the cœliac but mostly the renal and suprarenal plexus. The renal portion of the lesser splanchnic may arise independently from the last thoracic ganglion and is called the smallest splanchnic nerve.

The splanchnic nerves do not lie symmetrically on both sides but are inclined slightly to the left.

The two semilunar ganglia form the cœliac plexus. These are flat, irregularly shaped

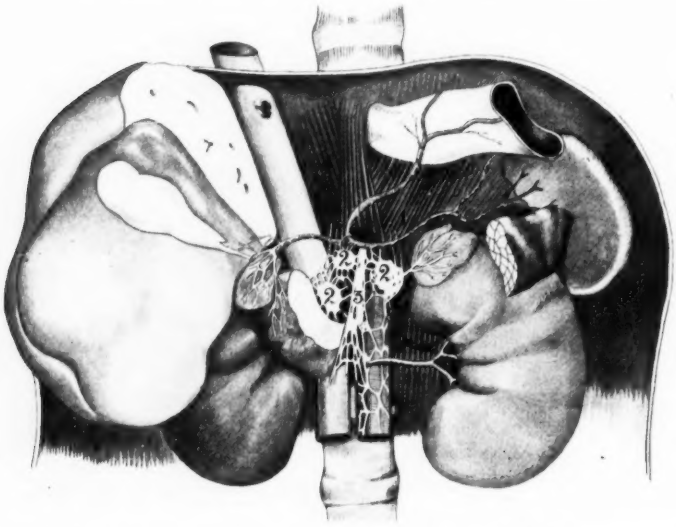

Fig. 1. *1*, Splanchnic nerves just below the diaphragm. *2*, Cœliac plexus. *3*, Superior mesenteric plexus. (From Buhre, Beitr. z. klin. Chir., 1919, cxviii, 60.)

masses. The left, usually smaller, is situated at the left of the cœliac axis, the right lies between the vena cava, the left lobe of the liver, and the head of the pancreas. The whole plexus forms a ring around the cœliac axis. The form of the plexus is variable; sometimes it is a uniform conglomerate, in other instances several independent ganglia can be made out. Each semilunar receives at its upper pole the greater splanchnic nerve whereas at the lower border, lying over the origin of the renal artery, the lesser splanchnic nerve enters.

From the cœliac plexus subordinate plexus are continued to the aorta and its branches. Because of the radial distribution of the fibers the name solar plexus has also been used. Paired and unpaired plexus are given off. The paired plexus are the phrenic, suprarenal, and renal, the spermatic in the male, and the ovarian in the female. The unpaired plexus are the hepatic, splenic, superior gastric, inferior gastric, and superior mesenteric. Caudalward the cœliac plexus is continuous with the abdominal aortic, inferior mesenteric, superior hypogastric, and iliac plexus.

The rami communicantes coming from the lumbar sympathetic trunk may enter the cœliac, but mostly join the aortic plexus. From the fourth lumbar on, the rami communicantes enter the hypogastric plexus.

This whole network of semilunar ganglia, splanchnic nerves, and rami communicantes together with abdominal branches of both vagi form the cœliac plexus. It is situated in the loose retroperitoneal, prevertebral space between the vertebral column, the posterior peritoneum, and the kidneys. If methylene blue is injected from behind at the height of the first and second lumbar vertebræ, as was done by Kappis in his first experiments, the solution stains the retroperitoneal spaces from the diaphragm to the pelvis. Thirty cubic centimeters were enough to fill the whole prevertebral space in the cadaver. In living tissue, however, with pulsating arteries and osmotic tension of the tissues more than 30 cubic centimeters are necessary. Clinical evidence has shown that if the fluid is not injected further down in the region of the third lumbar vertebra, only the cœliac plexus is blocked.

This prevertebral space in the height of the first and second lumbar vertebræ is an isthmic

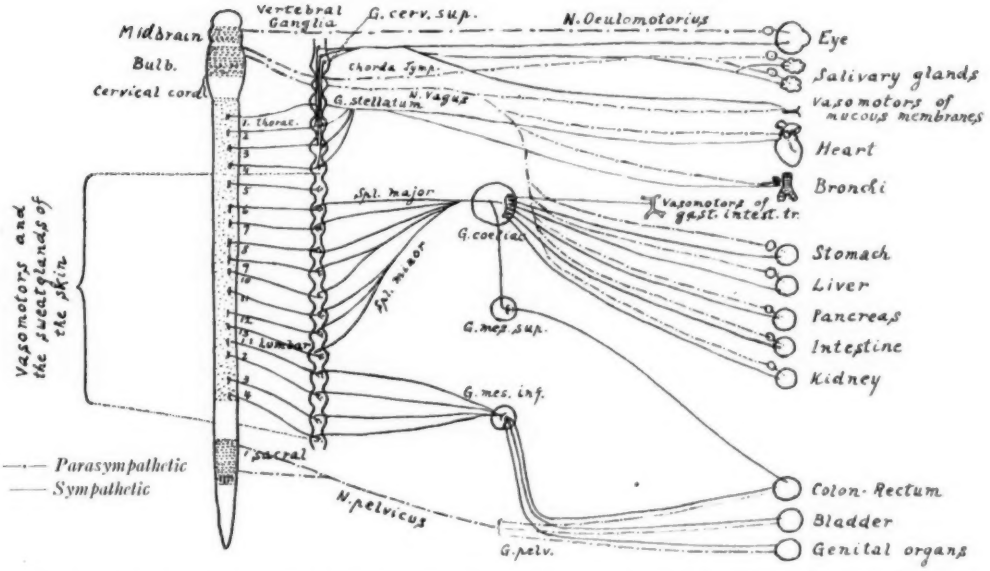

Fig. 2. Diagram of the autonomic nervous system. (From Meyer and Gottlieb, Experimentelle Pharmakologie, 3d ed. Vienna: Urban & Schwarzenberg, 1914.)

point, the meeting place of all plexus that collect the nerves of upper abdominal organs, namely the liver, spleen, stomach, duodenum, pancreas, and transverse colon. This space can be reached from behind, the needle entering beside the body of the vertebra—posterior route; or from the front, the needle piercing the lesser omentum between the aorta and vena cava—the anterior route.

PHYSIOLOGICAL CONSIDERATIONS

That part of the nervous system which innervates the involuntary organs has been called the sympathetic, vegetative, visceral, or finally, following Langley's nomenclature, the autonomic nervous system. Langley divides this system for anatomical, physiological, and pharmacological reasons into (Fig. 2)

1. Craniobulbar and sacral autonomic, parasympathetic system. Fibers come from the midbrain, bulbus, and sacral part of the cord. They pass through the oculomotor nerve to the sphincter papillæ and ciliary muscles; through the facial, intermediary, glossopharyngeal and vagus nerve to lachrymal and salivary glands, mucous membranes of mouth, nose and pharynx, to trachea, bronchi, heart, stomach, liver, pancreas, kidney, small intestines, and proximal colon. From the sacral part fibers go to the descending colon, rectum, bladder, and genital organs.

2. Thoracolumbar autonomic, sympathetic nervous system. Fibers come from the thoracic and lumbar part of the cord. Through the white rami communicantes, these fibers reach the sympathetic chain and its ganglia. As gray rami communicantes they pass from these ganglia to the spinal nerves.

Characteristic of the whole autonomic nervous system, including both groups is (1) that it is paralyzed by nicotine, (2) that a ganglion is always interposed between center and periphery, forming a synapsis between the two neurons. This synapsis can take place in the vertebral ganglia (ganglia of the sympathetic trunk) or prevertebral ganglia (cœliac, mesenteric, aortic, hypogastric). The two subdivisions, parasympathetic and sympathetic, are pharmacological antagonists. Adrenalin increases the action of sympathetic fibers whether they simulate or inhibit. Choline, physostigmine, and pilocarpine stimulate

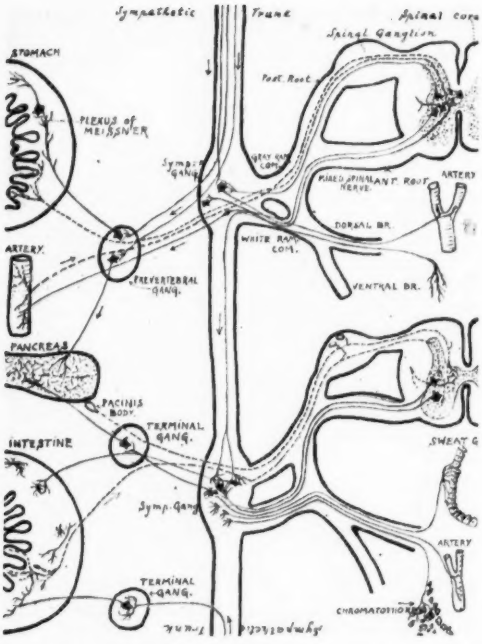

Fig. 3. The course of afferent and efferent sympathetic fibers as conceived by Langley and di Cajal. Motor neurons (straight lines); sensory neurons (interrupted line). Left side: visceral innervation; right side: cutaneous branches. (Modified from Castellino i Pende, Patologia del Simpatico, Dottor Francesco Vallardi, Milano, 1915, p. 27.)

parasympathetic fibers; atropine paralyzes them. While nicotine acts on the synapsis, these drugs act on terminal endings.

A third system, consisting of the plexus of Meissner and Auerbach is called by Langley the *enteric system*. These peripheral plexus are fairly independent from the autonomic nervous system, although they receive impulses from both sympathetic and parasympathetic nerves. These plexus are embedded in the peripheral organs and permit a certain independent activity even in the absence of higher centers.

The sympathetic fibers originate in the intermediolateral tract of the cord. As regards the sympathetic nerves, motor neurons and sensory fibers are present. The motor, efferent neurons always have a synapsis in one of the ganglia. The sensory efferent fibers coming from the periphery to the spinal cord seem to consist of only one neuron with the trophic center in the spinal ganglion. Others think that two or more neurons are present as in the efferent fibers (Fig. 3).

It is undecided whether the sensory fibers of the sympathetic nerves belong to the sympathetic system or are only carried in them. The practical conclusion is the same: the splanchnics carry the sensory fibers for a large group of abdominal organs and their block must result in anæsthesia.

This statement upon which the whole method of splanchnic block is based must be discussed in more detail as our conception concerning abdominal pain has changed recently.

THE SENSATION OF PAIN IN ABDOMINAL ORGANS

This problem has been investigated by physiologists on animals, but by surgeons on man especially since abdominal operations have been performed under local anæsthesia. The question of abdominal pain naturally falls into two subdivisions. The first type is the pain in the abdomen observed in acute colics, chronic inflammatory processes, intestinal obstruction, and so forth. We can go into this only as far as it is connected with the second variety: the pain caused during surgical procedures. These two varieties may be identical in quality but not necessarily so as older authors, especially the clinician Nothnagel, stressed the idea of inadequate stimulation in most of the surgical observations. Cutting or burning is not a physiological stimulus for the visceral nerves; contraction, dilatation of the viscus, or muscle spasm causing acute anæmia of the organs are the factors that cause spontaneous pain. Goldscheider speaks of the summation of small, normally nonperceivable stimuli, that result in pain. If it is true that the sympathetics are the sensory nerves of visceral organs, then in his opinion, stimuli of different quality and intensity must be responsible for pain. We shall see how the recent conception of abdominal pain as evolved by Neumann and Kappis explains this variety

Observations during laparotomy and corresponding animal experiments regarding pain in various organs upon cutting, burning, and

traction are of greater interest for our present subject. Lennander, doing his operations under local anæsthesia (1901-1906), was the first to make systematic observations and to evolve a theory of abdominal sensations. All organs innervated by branches of the vagus and sympathetics given off below the recurrent laryngeal nerve have no pain, pressure, cold, or warm sensations. Abdominal pain, whether spontaneous or surgical, is transmitted by spinal nerves ending under the parietal peritoneum, diaphragm, and retroperitoneal spaces. For certain chronic types of pain, Lennander assumes that a chronic lymphangeitis around the spinal nerves causes a constant irritation. While his theory in its original form is no longer acceptable, Lennander deserves great credit for turning surgical attention to these problems. Wilms accepted Lennander's theory, but emphasized the pain during traction on the mesenteries. The intestinal colic can be explained this way. A. W. Meyer, using adequate stimulation in cats, caused marked contraction of the intestine by barium chloride and dilatation by inflating the bowel with a rubber ball. Pain, however, was registered only when the mesentery was pulled.

In contrast with most of the authors, Ritter, then Kast and Meltzer, found that although the mere opening of the abdomen lowers the sensibility of the abdominal organs, yet there is sensation in various organs especially if they are inflamed. Many other more or less conflicting observations have been made. A complete bibliography of the subject up to 1910 is found in Neumann's critical review. Working in the Physiological Institute of Vienna from 1910 to 1912 Neumann produced clear cut experiments. In the frog the abdominal organs showed various degrees of sensibility when mechanical or chemical injury was applied. Cutting the splanchnics on both sides caused all pain reaction to cease. Cutting both splanchnics in dogs between the diaphragm and cœliac plexus resulted in anæsthesia down to the transverse colon. Crushing with clamps, pulling on the mesentery were not registered. The lower abdomen could be anæsthetized by cutting the connections of the inferior mesenteric plexus. A part of the sensory fibers may reach the cord through the lumbar rami cummunicantes, so that these had to be cut too. The sensory innervation then runs through the splanchnics but also through the sympathetic chain.

These experiments were unknown to Kappis, who independently from Neumann came to the same conclusions. Kappis' conception is the following: Sensory fibers go from the lateral parts of the cord through the rami communicantes, splánchnic nerves, and also through the first to the third lumbar rami communicantes directly to the retroperitoneal ganglia. From here the fibers accompany the blood vessels to the organs. The smaller the vessel, the finer the fiber. In the organs they are entirely missing or so fine that practically no sensibility is present. The following regions have sensory nerves present in sufficient number and caliber: mesentery, lesser omentum, the gastric attachment of the greater omentum; the region of the cystic, hepatic, and common duct; porta hepatis, renal hilus, and larger vessels. On this basis not only surgical but spontaneous pain may be explained. Further evidence in favor of this theory was furnished by V. Hofmann. In twenty experiments on man this author found that the visceral pleura has certain sensitive points. Parietal pleura and parietal peritoneum have many nerves shown by an impregnation method. Cats treated with intravital methylene blue had no nerves on the visceral peritoneum and on large areas of the mesenteries except around the blood vessels. Contripetal nerves in visceral organs were very scanty.

The best proof of this theory, however, is the clinical result of splanchnic block, which is perfect anæsthesia of the upper abdomen, showing that the splanchnics and solar plexus are the pain carrying elements. This view is contradicted by Labat who doubts whether the solar plexus or the splanchnics are the sole or chief paths of conduction of painful impulses. "Pain in gastric operations is chiefly due to traction on the parietal peritoneum resulting in the cleavage of retroperitoneal tissue, which is richly supplied by cerebrospinal nerves." This corresponds to

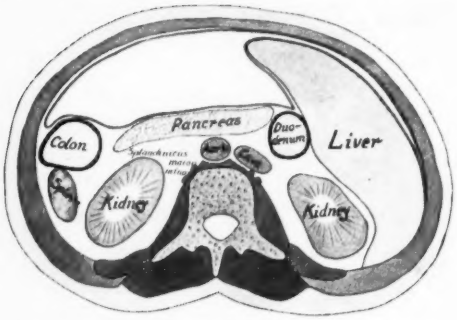

Fig. 4. Splanchnic anæsthesia. Posterior route. (From Kappis, Beitr. z. klin. Chir., 1918, cxv, 169.)

Lennander's theory. Labat's pupil Meeker goes a step further in stating that the "breaking of conductivity in the splanchnic nerves . . . is not in accordance with sound principles of anatomy and physiology. The pain . . . is caused by the stimulation of spinal and not sympathetic nerve filaments . . . ." Therefore "paravertebral block of the fifth dorsal to third lumbar nerves for intra-abdominal anæsthesia is anatomically and physiologically correct, but entirely impractical. Clinical experience with splanchnic anæsthesia proves it to be inefficient . . . . It is the least important of all the factors concerned in the success of an abdominal operation under local anæsthesia."

Meeker does not support this opinion with any experiments. The question whether the pain carrying fibers are sympathetic or spinal cannot be so easily settled, but that they run in the splanchnics is very probable. Paravertebral block itself, which seems more logical to Meeker, is a block of the intercostal nerve plus the ramus communicans. The nature of this latter is generally accepted to be sympathetic.

The underlying physiological principle, then, which led Kappis to perform splanchnic anæsthesia on man was the idea of blocking the splanchnic nerves and the lumbar rami communicantes with two injections at an isthmic point instead of blocking the rami communicantes individually, which meant 22 injections from the fifth dorsal to the third lumbar vertebræ on both sides.

As to the participation of the vagi in abdominal sensations, the clinical observations of Kocher on cord injuries have shown as early as 1896 that the vagi have no pain carrying fibers from the abdomen.

THE TECHNIQUE

The technical part of the problem was to deposit a satisfactory amount of novocain solution in the prevertebral loose connective tissue, anterior to the first, second, and third lumbar vertebræ. The way of approach is either from the back—posterior route—or through the open abdomen—anterior route. The two methods differ so much that a separate discussion has seemed advisable.

Posterior route. The original description of Kappis is the following: The patient lies prone with a cushion under the costal arch to bend the vertebral column. A 12 centimeter needle is inserted in the back 7 centimeters from the midline just below the twelfth rib and is pushed forward at an angle of 30 degrees to the sagittal plane. When the body of the vertebra is reached, the needle should slide along the lateral border of the vertebra until the bony contact is lost. It should never be pushed further than 1 centimeter from this point. After aspirating the syringe for blood, 20 to 40 cubic centimeters of a 1 per cent solution of novocain are deposited. The same injection is repeated on the other side (Fig. 4). The bilateral injections are repeated with the same technique at the height of the second lumbar vertebra and 10 to 20 cubic centimeters are deposited with the view of blocking the lumbar rami communicantes that do not enter the cœliac plexus.

Later, in 1920, Kappis modified his original technique by advising only one injection on either side of the vertebral column. Twenty cubic centimeters of the solution are deposited in the height of the twelfth rib, 20 cubic centimeters are given further cranially, and 20 cubic centimeters injected further caudally, by changing the angle of insertion but always remaining in the same plane, parallel to the bodies of vertebræ. He also recommends that the needle be kept away from the vertebra at a distance of ¼ to ½ centimeter. The solution is distributed this way more easily.

In a recent article Kappis seems to recommend only one injection on either side, without moving the needle cranially or caudally. A ½ of 1 per cent solution is used.

On the basis of anatomical studies Labat changed the angle of insertion from 30 to 45 degrees; otherwise his technique is the same. Hustinx found that injection on only one side, preferably the right gives the same results. Roussiel calls his method paravertebral, but describes exactly the route used by Kappis. He makes his second injection toward the third lumbar vertebra in lower abdominal work.

Anterior route. Approach by the anterior route was first suggested by Wendling, who inserted a needle through the intact abdominal wall, left liver lobe, and lesser omentum down to the retroperitoneal ganglia. The method, being unsafe and dangerous has not found any further application. It has developed however in the hands of Braun to a much safer procedure (Fig. 5). After the abdominal wall has been anæsthetized with about 150 cubic centimeters of a half per cent solution of novocain, the abdomen is opened, the incision reaching up to the xiphoid process. The left lobe of the liver is retracted upward, the stomach pulled gently downward and to the left. Thereby the lesser omentum is well exposed and laid on the stretch. The left index finger is now inserted at the highest possible point of incision and palpates through the lesser omentum the pulsating aorta. This should be pushed aside to the left by passing the tip of the finger to the vertebra. A fine needle of 12 centimeters in length is inserted alongside the finger. Thereby the aorta and vena cava are separated and in the loose, retroperitoneal, prevertebral tissue between the vena cava and aorta, 100 cubic centimeters of a ½ per cent solution of novocain-adrenalin are injected. The tip of the needle should be as close as possible to the diaphragm, above the origin of the cœliac axis, just in the midline. The needle should be carefully aspirated for blood before injection.

In order to facilitate the injection, several mechanical devices have been constructed. For the posterior route, Rebula constructed a metal guide to insure the angle of 30 degrees

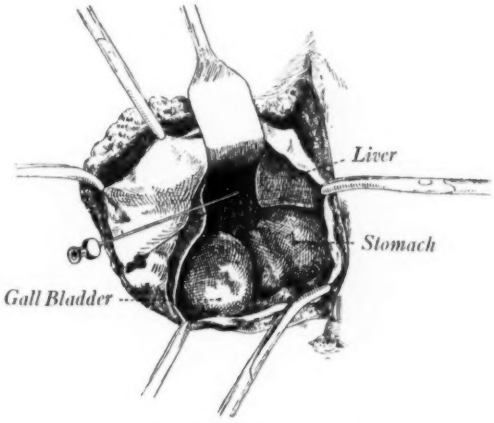

Fig. 5. Splanchnic anæsthesia. Anterior route. (From Buhre, Beitr. z. klin. Chir., 1919, cxviii, 60.)

of insertion. For the anterior route, Burke, Denman, Kirchmayer, and Quarella have described grooved directors or protecting tubes to give a safe sliding of the needle beside the gloved finger. I found the simple director of Braun easy to handle and convenient.

PREMEDICATION OF THE PATIENT

It is especially important in abdominal operations done under local anæsthesia, to diminish the anxiety and apprehension of the patient by the preliminary administration of sedatives. The usual preparation is the administration on the night before the operation of 0.5 gram of veronal or any other barbituric compound, and 1 to 2 centigrams (grain $^1/_6$ to $^1/_3$) of morphine with 0.5 to 1 milligram (grain 1/120 to 1/60) of atropine half an hour before the operation, the exact amount varying according to the weight and general condition of the patient. Scopolamine in doses of 0.3 to 0.5 milligram (grain 1/200 to 1/120) has been used by many authors, among whom are Kappis, Braun, Labat, and Schmidt. My personal experience is that the use of scopolamine is not free from danger especially if the patient loses a considerable amount of blood. With a low hæmoglobin count even a small dose of scopolamine (grain 1/200) may cause serious intoxication. Therefore it is better to refrain from its use. The usual preparation with morphine-atropine has also some dis-

advantages. Preiss and Ritter omitted this combination in 33 cases and noted that thirst, nausea, and excessive perspiration were markedly diminished.

DOSAGE OF NOVOCAIN

Kappis originally gave 60 to 100 cubic centimeters of a 1 per cent solution; his modified technique requires 120 cubic centimeters. In an article of 1925, he advocates 60 to 80 cubic centimeters of a ½ per cent solution. Metge used 80 cubic centimeters of a 1 per cent solution in his first and 50 cubic centimeters of a 1 per cent solution in his second series. Preiss and Ritter advocate 20 to 60 cubic centimeters of a 2 per cent solution. Their maximal dose was 80 cubic centimeters of a 2 per cent solution. Labat uses 80 cubic centimeters of a ½ per cent solution of neocaine (French novocain). Both Braun and Finsterer use ½ per cent solutions. The former uses 100 cubic centimeters, the latter does not like to use more than 70. In debilitated patients Finsterer uses ⅓ of 1 per cent solutions. With ¼ of 1 per cent tutocain he had the least amount of untoward symptoms during the operation. Quite recently 70 to 100 cubic centimeters of ¼ to ⅛ per cent of tutocain has been used by most authors instead of ½ per cent novocain, which meant a further decrease in the absolute amount of the local anæsthetic. From the study of various untoward effects, to be discussed later, the concentration of ½ per cent novocain should not be transgressed. In a very sick patient it is wise to use ⅓ to ¼ per cent solutions. In the use of 100 cubic centimeters of a half per cent solution for the splanchnic block and the very generous use of 150 cubic centimeters for the abdominal wall, the safe limit of 250 cubic centimeters of ½ per cent novocain is not transgressed. The unusually large amounts of 5.66 centigrams to the kilogram body weight as used by Scipiades, would mean 3.5 grams in a patient weighing 65 kilograms. His patients, curiously enough, do not show convulsions or cramps but are very somnolent. This general anæsthetic effect of novocain in excessive doses has also been reported by Mayer and others, and is an undesirable condition.

DURATION OF ANÆSTHESIA

The duration of the anæsthesia is given as varying from 2½ to 4 hours. It certainly is long enough for almost any surgical procedure in the abdomen. The average duration is 2 hours. Occasionally a reinfiltration of the abdominal wall has been made (Finsterer).

SUMMARY OF REPORTED CASES—POSTERIOR ROUTE

Two thousand four hundred and seventy-five cases of approach by the posterior route could be gathered from the available literature (Table I). An attempt has been made to make a complete list of all cases but probably some cases have been overlooked for which apologies are made to unknown authors. The results of splanchnic block were classified into three groups. In Group I are cases of perfect anæsthesia, with no complaint from the patient. In Group II, anæsthesia was sufficient with some complaints by the patient. The operation was carried on without any further aid or a light general anæsthesia was administered, never exceeding 30 to 50 cubic centimeters of ether. In Group III are the failures, in which a deep general anæsthesia had to be given. In calculating the percentages for the number of cases showing untoward symptoms and for the number of deaths, the total sum of 2,335 was used. I was unable, however, to use this same number for calculating the number of efficient anæsthesias. Some articles do not give an exact account of the percentage of results according to my classification. Furthermore the English surgeons administer a light general anæsthesia with the splanchnic block, so that no observation could be made regarding the sole effect of splanchnic anæsthesia. After subtracting these cases, a total of 1,712 cases remain for the study of the grade of anæsthesia obtained by posterior injections.

Of the 1,712 cases, 1,288, 75.23 per cent, are reported as completely successful. While the individual reports vary very much according to the judgment of the author, in most cases these variations are well ruled out. In 230 cases, 13.43 per cent, anæsthesia was sufficient or partial failure resulted; whereas in 194, 11.33 per cent, failure was complete.

TABLE I.—SPLANCHNIC ANÆSTHESIA—POSTERIOR ROUTE[1]

Year	Author	No. Cases	Results			Untoward Symptoms	Deaths	Remarks
			I	II	III			
1918	Kappis	200	?	?	?			No failures mentioned.
1919	Naegeli (Garre)	18	13	2	3	1 collapse		Failure due to bad technique.
1919	Preiss and Ritter (Clairmont)	89	80	5	4	1 collapse		2 failures: Infiltrated retroperitoneum. 2 failures: faulty indication
1919	Denk (1) (Eiselsberg)	85	51	34	0	1 pleural puncture 1 tip of needle broke		
1920	Denk (2) (Eiselsberg)	*40					1 death during injection	
1920	Heller	1					Death during injection	
1920	Khautz	1	1				Death shortly after injection	
1920	Labat (1) (Pauchet)	12	9	1	2			
1920	Paul (Haberer)	25	16	6	3	1 delirium 1 double vision		
1920	Preiss (Clairmont)	*103	89	14				In 63 cases no morphine
1921	Bérard and Dunet	1	1			Postoperative pneumonia		
1921	Bouma	11	9		2	1 collapse		Reports blood pressure curves.
1921	Graef	12	6	4	2		1 death in complete obstruction	
1921	Graf	50	34	13	12			
1921	Jirasek (Kukula)	114	98	9	7	1 asphyxia	Death after 5 hours	
1921	Labat (2)	*22	21	1		2 partial anæsthesias of lower extremities		
1921	Kanavel	1	1					
1922	Gandusio and Postoschnig	18	15	3				
1922	Gutiérrez	30	23	3	4			
1922	Perrier	18	16		2			2 failures in ileus.
1922	Quarella	11	10	1				Partial failure due to cancerous infiltration of lesser omentum.
1922	Scipiades	84	59	12	13	Great somnolence in many cases		Splanchnic combined with parasacral; 5.66 ctgr. novocain per kilo.
1922	Wiemann	8						
1923	Hustinx	119	73	33	13	2 collapses	1 death	
1923	Kutscha-Lissberg	178	170	6	2	7 collapses		Splanchnic combined with spinal.
1923	Langenskiöld	28	11	9	8			
1923	Metge (1) (Mueller)	112	93	8	11	Marked lowering of blood pressure		Uses 80 c cm. of 1 per cent novocain.
1923	Mirizzi	33	?	?	?			
1923	Roussiel	156	153		3			
1923	Schmidt	40	?	?	?			Only slight fall in blood pressure.
1924	Fischer	5	3	1	1			
1924	Hillman	18	All patients received light general anæsthesia			Average fall in blood pressure 88 millimeters		
1924	Labat (3)	2	2					
1924	Metge (2) (Mueller)	*44	27	10	7			
1925	Apperly	91	Always combined with light general					
1925	Cade	27	Always combined with light general					
1925	Graf (2)	260	?	?	?	1 collapse 6 hr. post op.	1 death 3 hr. post. op.	
1925	Harke (Kappis)	28	?	?	?			Pituglandol seemed to prevent fall in blood pressure.
1925	Hewer	11	Always combined with light general					
1925	Lundy (Mayo)	184	102	15	67			
1925	Meeker (Mayo)	42	23	19				
1925	Silva	28	25		3			
1926	Borszéky	100	54	21	25	Marked fall in blood pressure in every successful case	1 death 1½ hr. after the injection	
Total		2475	1288	230	194	14 collapses 0.56% 1 pleural puncture 1 delirium 1 double vision 2 anæsthesia of lower extremity	8 deaths 0.32%	
Percentage			75.23	13.43	11.33			

*This figure covers new cases only.

The reason for insufficient anæsthesia may be found in various factors. Several authors state that with increasing experience the number of their failures diminished. Faulty technique then may be one of the causes of poor anæsthesia. Another cause may be the obliteration of the prevertebral loose connective tissue from inflammatory or carcinomatous infiltration of the lesser omentum and the retroperitoneal tissues. The injected fluid cannot diffuse itself, and an equal distribution around the ganglia and splanchnic nerves will not take place. Preiss and Ritter, and Quarella report such cases. Finally the use of splanchnic block in lower abdominal lesions will naturally result in a failure. In appendectomy and in ovariectomy as reported in one of the first reports in 1919, no anæsthetic effect can be expected.

In the effort to improve these results, it is only the unforeseen infiltration of the prevertebral space that seems unavoidable. In the anterior route this condition can be anticipated.

Causes of untoward symptoms. We note 14 cases of collapse in 2,475 cases, 0.56 per cent. The analysis of these cases gives us very interesting information concerning the comparatively high incidence of collapse.

Intravenous injection. An immediate collapse after injection is almost invariably due to intravenous injection of novocain. Such was the case reported by Preiss and Ritter, who injected 10 cubic centimeters of a 2 per cent solution of novocain intravenously. A deep collapse with respiratory failure ensued, but the patient revived after 10 minutes. Three weeks later the anæsthesia was repeated with perfect success and without harm. In a case of Jirasek, the injection was followed by asphyxia, and resulted in death. In analyzing the deaths, we will come back to this point. Serious collapses were reported in posterior splanchnic anæsthesia by Massari (unpublished), Paul, Finsterer, and Hustinx. Paul mentioned 1 case of hallucination which occurred in Haberer's clinic, and Haberer at the Surgical Congress in Berlin added 2 others. While hallucinations may follow any surgical operation, it has been frequently stated that intravenous novocain injections, in larger doses, have resulted in delirium or disorientation.

Intraspinal injection. A further possibility is intraspinal puncture. Finsterer reports having observed twice the escape of spinal fluid in his first anæsthesias done by the posterior method. Denk reports that in successful splanchnic anæsthesia good relaxation of the abdominal wall is obtained. This may be due to partial spinal anæsthesia. It is not impossible, however, that by anæsthetizing the abdominal organs, the reflex spasm of the abdominal wall is relieved. Paul's case of double vision after splanchnic block, which occurred at Haberer's clinic, can be explained only by spinal anæsthesia.

Paravertebral injections. Collapse occurring immediately after injection can be due only to intravenous or intraspinal injection, as pointed out by Finsterer. It cannot be attributed to the absorption and toxic effect of novocain, because the time between injection and collapse is not long enough. We do know however that absorption from the paravertebral spaces is more rapid than that from most parts of the body. Muroya has shown that in rabbits only $^1/_6$ of the maximal nontoxic subcutaneous dose can be used paravertebrally, and that the rate of absorption is doubled in paravertebral injections. It was possible to follow the colored fluid along the nerve roots into the intervertebral foramina and the epidural canal. On the basis of these animal experiments I believe that if the fluid is deposited paravertebrally and not prevertebrally, the possibility of a seepage into the epidural or even spinal canal may be considered even if a spinal puncture has not taken place. Labat speaks of 2 cases in which a partial anæsthesia of the lower extremities was observed. While this might be explained by an unusually wide diffusion of the fluid to the lumbar segments, a partial epidural or spinal anæsthesia may have taken place.

Large dose of novocain. Furthermore collapse may be due to the toxic effect of novocain which in this region, as just mentioned, is more toxic than elsewhere. Therefore the use of weak concentrations and smaller quantities seems advisable. This brings up the question of dosage. The doses of most

authors discussed transgress the limit of safety. One hundred cubic centimeters of a ½ per cent solution of novocain or 1/5 per cent of tutocain should never be exceeded. A further reason for collapse may be the block of the vasomotor system. In Metge's very extensive studies on the physiology of splanchnic block this possibility cannot be substantiated. In one-fifth of 109 cases the mesenteric veins were dilated, but the lowering of the blood pressure did not coincide with this dilatation.

Puncture of the pleura. In the 2 published cases (Denk, Preiss and Ritter) of puncture of the pleura, no evil consequences were suffered. An immediate cough and bloody sputum for 1 or 2 days were characteristic.

In one of Denk's cases the tip of the needle broke but was removed without difficulty.

Blood pressure changes. Kappis, the originator of the posterior method, stated in his first publications that the blood pressure sinks only 15 to 20 millimeters mercury. The same was stated of the anterior method by Buhre who pointed out that any laparotomy may cause some fluctuations. Bouma was the first to give exact curves of blood pressure during splanchnic anæsthesia. In 5 of 11 cases marked lowering was found. In one of his curves the systolic blood pressure dropped from 150 to 50, in another from 140 to 40. Of great interest was an observation in which only a needle puncture was made but no novocain injected. The curve dropped just the same. Wiemann reported 8 cases of which 4 showed a moderate increase, 3 a decrease, and 1 no change in blood pressure. He does not attach much importance to psychic effects, but thinks that all prevertebral injections cause a fall in blood pressure. In the average case there was a slight decrease. An extensive study of the physiological effects of splanchnic anæsthesia was made by Metge. I have tabulated his first 104 cases in Table II. The second series is tabulated in Table II, Part 2.

Both tables show that the more perfect the anæsthesia, the more marked is the fall in blood pressure. This would mean that this effect is present whenever the splanchnic nerves are totally blocked, as might be expected in a block of the abdominal vasomotors. Actual observations, however, do not substantiate this assumption. The mesenteric veins were dilated in one-fifth of the first series of 104 cases. This finding did not coincide at all with the findings in cases in which blood pressure was markedly lowered. A criticism that must be made of Metge's very accurate investigations is that he used a 1 per cent solution, and gave 80 cubic centimeters in the first series. In his second article he advocated the use of 50 cubic centimeters of a 1 per cent solution. Muroya's experiments, which were mentioned above, indicate that this is an excessive dose. The lowering of blood pressure in Metge's cases cannot be of intraspinal or intravenous origin because it comes on gradually 10 to 30 minutes after the injection (Fig. 6). It seems to be a symptom of overdosage reinforced by the block of vasomotors. In Hillmann's 49 cases, 9 had an average fall of 88 millimeters mercury. Koenig in 1 case saw a typical curve with lowering after 30 minutes and rising before the operation was over. However he emphasizes the fact that in every operation under local anæsthesia the blood pressure increases. This is psychic and not attributable to the adrenalin in the solution. Denman, using a 1 per cent solution, observed an average drop of 30 millimeters mercury. Borszéky observed

TABLE II, PART 1.—CHANGES IN BLOOD PRESSURE DURING SPLANCHNIC ANÆSTHESIA

Blood Pressure	Cases	Failures	Failures per cent
No change	6	3	50
Moderate lowering (from ⅔ to ½ of the original value)	20	5	28
Marked lowering (below ½ of the original value)	78	3	7
Total	104	11	10.5

TABLE II, PART 2.—CHANGES IN BLOOD PRESSURE[1]

Result	Cases	Blood pressure dropped Below Half	Less than Half	Not at all
Group I	74	42	22	8
Group II	3	..	1	2
Group III	10	3	2	5
Total	87	45	25	15

[1] In Group I, the anæsthesia was perfect; in Group II, satisfactory; in Group III, insufficient.

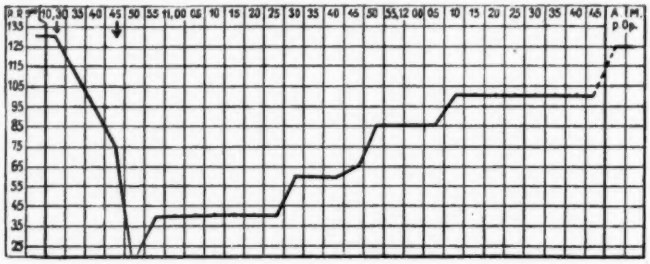

Fig. 6. Typical lowering of blood pressure following splanchnic anæsthesia. R. R. Systolic blood pressure. First arrow, splanchnic anæsthesia; second arrow, operation started. Patient was a woman, 58 years of age, with cancer of the stomach; the operation was gastrectomy. (From Metge, Deutsche Ztschr. f. Chir., 1923, clxxviii, 37–59.)

a fall in blood pressure in proportion to the anæsthetic effect. Finally as a proof that the excessive blood pressure changes in Metge's cases are due to the dosage, I may cite Schmidt's observations on 40 cases of posterior splanchnic anæsthesia. In 12 cases he noted an average rise of 11 millimeters, in 22 cases an average fall of 11 millimeters, and in 4 cases no change. On the whole a sinking of 3.7 millimeters mercury took place. His dosage was 80 to 100 cubic centimeters of a half per cent solution. In A. Hofmann's cases the blood pressure sank 3 to 20 millimeters. When the abdominal wall block was made before the splanchnic anæsthesia no lowering was observed.

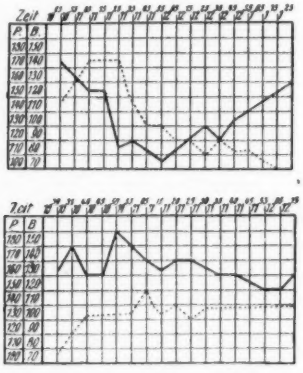

Fig. 7. The effect of pituitrin on the blood pressure curve. P = pulse = dotted line. B = blood pressure = straight line. Upper chart: Woman, 36 years of age; partial gastrectomy; splanchnic anæsthesia with 60 cubic centimeters of 0.2 per cent tutocain; abdominal wall blocked with 140 cubic centimeters of 0.2 per cent tutocain. No pituitrin. Lower chart: Woman, 23 years of age; partial gastrectomy; splanchnic anæsthesia with 60 cubic centimeters of 0.2 per cent tutocain; abdominal wall blocked with 160 cubic centimeters of 0.2 per cent tutocain, 1 cubic centimeter of pituitrin subcutaneously. (From Harke, Zentralbl. f. Chir. 1925, lii, 567.)

To overcome the fluctuations of blood pressure, Harke, in a recent article from Kappis' clinic, advocates the prophylactic injection of ½ to 1 cubic centimeter of pituitrin, 10 minutes before the splanchnic block. In 24 of 28 cases no lowering of blood pressures was noted. Harke's curves are very convincing (Fig. 7.) This measure together with the use of half per cent solutions of novocain which can be reduced to even ¼ per cent in especially bad risks, gives the best protection against large fluctuations of the pressure curve. The adrenalin in the novocain solution counteracts favorably the depressant action of vasomotor paralysis.

Pulse. The rise and fall of the pulse does not seem to be parallel with that of the blood pressure. It depends greatly on fear, excitement, and pain. In Bouma's cases the fall in blood pressure was accompanied by a slowing down of the pulse rate from 166 to 48, from 100 to 55. In most cases, however, the pulse rate increases. Denk advocates the use of preliminary atropine (1 milligram subcutaneously) to diminish the reflex irritability of the heart. The pulse rate is influenced by so many factors, that its value is much inferior to that of blood-pressure readings.

Temperature. Metge has taken the rectal temperature in 40 cases during splanchnic anæsthesia. Altogether it seems to sink

simultaneously with blood pressure. Of 20 cases with great fall in blood pressure 9 showed temperature below 35 degrees C., 1 case even 34 degrees. Of 15 cases of moderate fall in blood pressure, only 2 showed a drop in temperature. The most interesting fact is that in 5 cases without any change in blood pressure 3 showed a lowering of temperature. So far as I know, control experiments with other laparotomies under general anæsthesia have not been made but it is known that long abdominal operations will cause a marked fall in rectal temperature. As stated above, Metge's 1 per cent solutions seem too high and the estimation of his findings, though very instructive, is not conclusive.

Peristalsis. Because of the antagonistic innervation of intestines, the block of sympathetic fibers should cause a predominance in the vagus system with increased peristalsis. This has been observed and even used therapeutically in spinal anæsthesia. Metge reports marked peristalsis of the stomach, jejunum, and colon in one-fifth of his cases. In 1 case the stomach was anæmic, the mesenteric vessels were hyperæmic, and marked intestinal contractions were seen. Kutscha-Lissberg thinks that strong contractions of the intestines may even cause volvulus or inner incarceration. However, he uses great doses of spinal, in combination with splanchnic, anæsthesia.

Late effects. Very little mention is found of late effects in the literature. Metge thinks that bowel movements are a little delayed. First winds were observed on the second day, first bowel movements on the third day with the help of enema, neohormonal, or atropine. The fact that atropine is effective, which has also been true in my limited experience, would seem to indicate that the intestinal paralysis is of a spastic and not of paralytic nature. This may not be of disadvantage in abdominal operations in which postoperative paralysis is often encountered.

Deaths. The following data are available concerning fatalities in connection with splanchnic anæsthesia.

CASE 1 (Heller). Posterior route. Old cachectic male patient. Diagnosis, cancer of the stomach. Fifty cubic centimeters of a half per cent solution were injected on one side in the lateral lying position. The syringe was aspirated for blood after the injection of each 10 cubic centimeters. When he was turned over to the other side, the patient was found dead. No cramps, no air hunger, and no cough had been noted. Postmortem showed no hæmatoma. The œdema due to the injected novocain could not be found. All arteries and veins in the neighborhood were examined carefully for lesions of the intima, but nothing was found. Heller attributes death to sudden lowering of blood pressure because of splanchnic block.

Evidently an intraspinal injection had taken place. As death followed the injection immediately and an intravenous injection can be in all probability excluded, this is the best explanation of the death. That a one-sided splanchnic block should cause immediate death purely because of vasomotor block is contrary to all experience.

CASE 2 (Denk). Posterior route. An old cachectic patient, with peritonitis due to perforation of unknown origin, suffered collapse and died during injection. Postmortem revealed a gangrenous incarcerated perforated bowel. Denk cannot determine a sure connection between death and the anæsthesia. The patient came to the operating room *in extremis.*

CASE 3 (Khautz). Posterior route. In a male patient 48 years old, with ulcus duodeni, 30 cubic centimeters of a 1 per cent solution were injected on the right, 20 cubic centimeters on the left. Shortly after the second injection unconsciousness and respiratory paralysis occurred. Postmortem showed entirely negative results at the site of injection. Death was attributed to respiratory failure.

An intravenous injection, as Finsterer points out, cannot be excluded by finding no hæmatoma at the site of injection. The vein may contract after the puncture with the fine needle.

CASE 4 (Graef). Posterior route. A male 61 years old, with carcinoma of the splenic flexure and complete obstruction was brought in collapse to the operating room. Cæcostomy was done, and the patient died on the table. Postmortem showed complete obstruction due to carcinoma at the splenic flexure. The proximal colon, greatly dilated, showed ulcers, with beginning peritonitis and free fluid in the abdomen. Death cannot be surely attributed to splanchnic anæsthesia. However, it was not good judgment to use it in a case of collapse.

CASE 5 (Jirasek). Posterior route. Only a short abstract of this case was available. The dose was 60 cubic centimeters of a 1 per cent solution combined with spinal anæsthesia. Asphyxia occurred after injection, lasted an hour and a quarter, and ended fatally after 5 hours. No further data.

CASE 6 (Kutscha-Lissberg). Posterior route. Diffuse peritonitis was present. Splanchnic anæsthesia was combined with spinal, 0.75 grm. novocain being used intraspinally. The dosage must be a misprint, the highest dose for spinal anæsthesia being 0.15 gram of novocain.

CASE 7 (Graf). Posterior route. A 47-year-old cachectic male was given 50 cubic centimeters on each side of half per cent solution by probatory incision. No abdominal pathological condition was found. The patient died 3 hours after the operation in deep collapse.

This case might have been one of cardio-vascular disease. The laparotomy together with the splanchnic anæsthesia was responsible for the death.

CASE 8 (Borszéky). Posterior route. One hour and a half after a technically correct injection death occurred. Postmortem examination showed that the suprarenal body had been punctured. No further pathological changes. No further data were available.

Some other deaths have been reported in which splanchnic anæsthesia was used but in which the cause of death could hardly be attributed to the anæsthesia. Naegeli's patient collapsed immediately after the injection and died 3 days after the operation. Postmortem showed a chronic leptomeningitis.

In Metge's series of 109 cases, 23 deaths occurred. In no instance was a lesion in the intima of the neighboring vessels found. In 1 case of death from pneumonia, the cortex of the right kidney was punctured. In another case a flat hæmatoma was found retroperitoneally. In both these cases blood could not be aspirated through the needle at injection. Finally he reports a case in which splanchnic anæsthesia may or may not have been responsible for death. In this case an embolus developed in the femoral artery. At postmortem an embolus was found in the aorta just below the renal artery. The opinion of the pathologist was that while this is a typical site for spontaneous thrombosis, the influence of splanchnic anæsthesia cannot be ruled out entirely.

CONCLUSIONS—POSTERIOR ROUTE

From the analysis of these cases, the following conclusions can be drawn:

1. All deaths occurred after injections by the posterior route.

2. Intraspinal and intravenous injections are probably responsible in Cases 1 and 3 respectively. The former can best be avoided by injection in the sitting and not lying position and by close observation of the angle of insertion. The latter should be ruled out by frequent aspirations for blood, but as Metge's two cases show, this is not an absolute safeguard. It is a good plan not to aspirate rapidly and to inject a few drops of the solution before aspirating, as the needle may be plugged by the tissues.

3. Spinal anæsthesia, which in itself is dangerous in upper abdominal operations, should not be combined with splanchnic anæsthesia. The complete block of all vasomotors, and further, the necessarily high doses of novocain make this combination responsible for death in Cases 5 and 6.

4. Patients in shock with the low blood pressure seen in complete obstruction and in peritonitis, should not be submitted to splanchnic anæsthesia. Cases 2, 4 and 6 again, while death would have occurred in all probability without the splanchnic anæsthesia, should not have been submitted to this additional risk. For colostomies an abdominal wall block is sufficient. Because toxic vasomotor paralysis occurs in cases of peritonitis when the intra-abdominal pressure is suddenly relieved, the abdominal vessels will fill up with blood and death will follow.

SUMMARY OF REPORTED CASES—ANTERIOR ROUTE

One thousand two hundred and ninety-two cases are available for study and the results have been classified in three groups as in the other series (Table IV). Here again the grade of anæsthesia cannot be studied on all records. Only 808 cases are available. In 701 of these (86.75 per cent) anæsthesia was complete, in 74 (9.15 per cent) sufficient, and in 33 (4.08 per cent) it was a failure. The reasons of failure are reported as hysteria without abdominal disease, 1 case; abnormal obesity, 1 case; a pathological involvement of the lesser omentum as a cause of failure is reported twice.

Collapse is mentioned in 2 instances by Langenskiöld, in both cases occurring before the injection was given.

No intraspinal or intravenous injections were reported. The former is anatomically impossible.

Fall in blood pressure is reported in Metge's cases. Of 11 cases 5 had marked fall (below

TABLE IV.—SPLANCHNIC ANÆSTHESIA—ANTERIOR ROUTE

Year	Author	No. Cases	Results			Untoward Symptoms	Deaths	Remarks
			I	II	III			
1919	Buhre (Braun)	58	57		1			1 failure due to hysteria. No abdominal pathological condition.
1920	Buhre (Braun)	46	43		3			1 failure in abnormal fat person. 2 failures due to infiltration in lesser omentum.
1921	Buhre (Braun)	96	82		14			
1923	Langenskiöld	17	5	7	5	2 shocks before injection.		
1924	Bachlechner (Braun)	400	?	?	?			
1924	Finsterer	508	457	51				In partial failure 30 to 50 cubic centimeters of ether was given.
1924	Metge (Mueller)	13	11	2		5 marked; 4 moderate lowering of blood pressure; Fall in blood pressure		
1925	Denman	84	?	?	?	Blood pressure dropped 30 points in the average		
1926	Borszéky	70	46	14	10			
Total		1292	701	74	33		0	
Percentage			86.75	9.15	4.08			

half), 4 moderate lowering, and 2 cases did not show any change. As stated above, his dose is too high. Denman reports a drop of 30 points on the average.

The absence of untoward effects in the reports is very striking. The conditions in which failures may arise are well defined and can be recognized. No deaths have been reported in the anterior route series.

COMPARISON OF THE TWO METHODS

Table V shows the comparative results of the two methods. It is only fair to state, however, that the better results of the anterior route are influenced by the fact that they consist almost entirely of cases of Braun and Finsterer who are both experts in this field. Nevertheless, the following advantages besides the better results are to be mentioned:

1. No pleural injection is possible.
2. No intraspinal injection is possible.
3. The possibility of intravenous injection is practically nil. By the posterior route, the vena cava, the left renal vein, and the renal artery have all been punctured. Puncture of the kidney or the liver is also possible. Most of the blood, however, comes from the intercostal arteries. In Metge's cases of the posterior route, one-third had blood dripping from the needle. The fluid injected from the posterior route may be deposited in the niche between the transverse process and the body of the vertebra, where absorption is unusually rapid.
4. The injection, under the guidance of the left index finger is much surer to reach the right place. Its effect is therefore more certain.
5. No deaths have been reported by the anterior route.

The disadvantages of the anterior route are the following:

1. A laparotomy starting from the xiphoid

TABLE V.—COMPARISON OF TWO METHODS[1]

	Posterior Route	Anterior Route
Number of Cases	2,475 (1,712)	1,292 (808)
	Per cent	Per cent
Group I.	75.23	86.75
Group II.	13.43	9.15
Group III.	11.33	4.08
Collapse.	0.56	0.15
Deaths.	0.32	0

[1]The numbers in parentheses indicate cases in which estimation of results could be made.

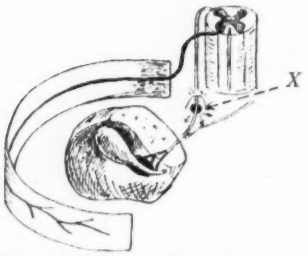

Fig. 8. Splanchnic anæsthesia relieves gall-bladder colic and muscular rigidity. (From D. Kulenkampff, Zentralbl. f. Chir., 1923, l, 211.) *X*, Interruption of sensory impulses.

process is necessary. This excludes lower abdominal and lumbar operations from anterior block.

2. The method of Braun, because it requires traction on the stomach, is painful. Braun mentions himself, that some patients need a few whiffs of ethyl chloride for the injection. In my limited experience an injection of 10 cubic centimeters of a half per cent solution into the lesser omentum, close to the left gastric artery has rendered the traction on the stomach painless.

3. Diagnostic or therapeutic injections, as advised by Naegeli, Labat, Kappis, and Jirasek, can be made only by the posterior route. These authors have shown that colics of visceral origin may be stopped and the process itself favorably influenced (ureteral stone) by splanchnic block. Kulenkampff emphasized the fact that muscular rigidity will disappear in a colic after splanchnic anæsthesia, if it is of reflex origin (Fig. 8). If however the rigidity is due to a peritoneal involvement resulting from the continuous extension of the inflammation or to adhesions, the rigidity will not be influenced.

4. The anterior route with the typical injection between aorta and vena cava above the cœliac axis, only anæsthetizes the upper abdominal organs. The posterior route attempts to block the upper lumbar rami communicantes. This part of the anæsthesia, however, as shown by 2 cases of Preiss and Ritter (appendectomy, ovariectomy) is not satisfactory.

The method to be preferred then is the anterior route, in case of an upper abdominal,

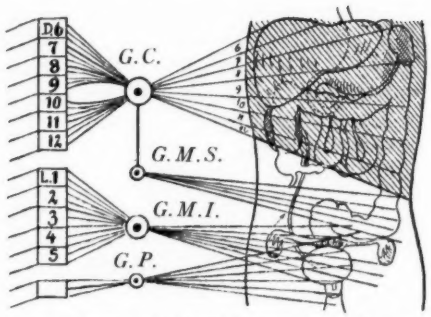

Fig. 9. Diagram of visceral innervation. *G. C.*, cœliae ganglion; *G. M. S.*, superior mesenteric ganglion; *G. M. I.*, inferior mesenteric ganglion; *G. P.*, pelvic ganglion. (From Kulenkampff, Zentralbl. f. Chir., 1923, l, 211.)

well localized lesion. The posterior route is not quite as effective and involves some additional dangers. For gynecological operations or rectal carcinoma, the block of the hypogastric plexus at the height of the fifth lumbar vertebra from behind seems to be much safer than the posterior splanchnic block because of simpler anatomical conditions.

ADVANTAGES OF SPLANCHNIC ANÆSTHESIA OVER OTHER METHODS

1. Splanchnic anæsthesia has all the advantages of local over general anæsthesia: diminution of chest complications, diminution of gastro-intestinal paralysis, absence of vomiting, and absence of shock as a result of the block of the afferent impulses. In patients with lesions of the heart, liver, and kidney, it adds no additional organic strain. The consciousness of the patient, if so desired can be easily taken by a few whiffs of nitrous oxide or ethylene.

2. The advantages of splanchnic over paravertebral anæsthesia are that, instead of 20 to 22 punctures, which are painful because of the search for the lower margin of the rib and dangerous because of the amount of fluid, the vicinity of the pleura and the spinal canal, one single injection will block the rami communicantes from the sixth dorsal to the twelfth dorsal vertebræ (Fig. 9).

INDICATIONS AND CONTRA-INDICATIONS

1. Anterior splanchnic anæsthesia is indicated in well localized upper abdominal

lesions. The older and more handicapped the patient and the longer the planned operation, the more advisable is its use. In operations on the stomach, biliary passages, and spleen perfect anæsthesia is obtained in 88.75 per cent of cases, a fair anæsthesia in 8.13 per cent, while complete failure is reported in 3.12 per cent. No death is reported. Only 2 cases of collapse occurred in this series, both before injection.

2. Anterior splanchnic anæsthesia is not indicated in explorations of the entire abdomen, in lower abdominal lesions, and in complete obstruction, when abdominal wall block and rapid colostomy would give the best results. In diffuse peritonitis, where again short interventions are essential and a toxic vasomotor paralysis is present, splanchnic anæsthesia does not seem justifiable. However, Jirasek reports that his mortality from peritonitis sank from 48 per cent to 28.2 per cent after he began the use of splanchnic anæsthesia.

It has been a failure (a) in abnormally fat patients when the aorta cannot be pushed to the side; (b) in the presence of contracted lesser omentum and retroperitoneal tissues where the fluid cannot become diffused; (c) in functional complaints when no pathological condition can be found in the abdomen.

CONCLUSIONS

1. The terms posterior and anterior splanchnic anæsthesia are recommended to take the place of the terms used by various authors.

2. The prevertebral space in front of the first and second lumbar vertebræ is an isthmic point where the sensory fibers of the upper abdominal organs unite to form plexus.

3. Experimental and clinical evidence show conclusively that the block of the splanchnic nerves on both sides results in an anæsthesia of the upper abdominal organs. The lower abdomen can be anæsthetized by adding to the splanchnic block the anæsthesia of the lumbar rami communicantes. The underlying physiological principle then which led Kappis first to use splanchnic anæsthesia on man was the idea of blocking the splanchnic nerves and rami communicantes at an isthmic point instead of blocking the rami communicantes individually by paravertebral injections from the sixth dorsal to the third lumbar vertebræ.

4. The best premedication is the oral administration of veronal for the night, and a preliminary morphine-atropine injection half an hour before the operation. The use of scopolamine is not advised. In some cases morphine-atropine has also been discarded. Pituitrin is helpful in the maintenance of the blood pressure level throughout the anæsthesia.

5. The safest dosage of novocain seems to be 70 to 100 cubic centimeters of a half per cent solution. In bad risks solutions of ¼ per cent of the same amount are advisable. One per cent or 2 per cent solutions have given untoward effects. Adrenalin 10 drops of 1:1000 solution to the 100 cubic centimeters should always be added. Instead of novocain, the same amount of tutocain in a concentration of ¼ to 1/6 per cent has proved equally satisfactory.

6. The technical part of the problem was to deposit satisfactory amounts of this solution in the prevertebral loose connective tissue before the first lumbar vertebra. The way of approach is either from the back or through the open abdomen. In 2,335 cases anæsthesia was induced by the posterior route; in 1,222 cases by the anterior route. A comparison of the untoward effects and dangers of the two methods as to efficiency shows that the anterior route is superior to the posterior route.

7. Anterior splanchnic anæsthesia is indicated in operations for upper abdominal well localized lesions. The longer the operation is apt to last, and the more handicapped the patient is by the degeneration of parenchymatous organs, the more beneficial will be its use. It is not indicated in diffuse abdominal conditions or in lesions below the transverse colon, or in short operations on good risks.

8. The advantages of splanchnic anæsthesia over general anæsthesia and paravertebral block in well selected cases is proved by ample clinical evidence.

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STUDIES IN STERILITY IN WOMEN[1]

By JOHN OSBORN POLAK, M.Sc., M.D., F.A.C.S., Brooklyn

STERILITY and fertility in the human female are always subjects which awaken the keenest interest in the minds of both gynecologist or sociologist—for socially, economically, and ethically, no marriage has attained its highest purpose without offspring. Both of these conditions have been the subject of many recent contributions, yet no collective review on the subject has appeared for a considerable time. It is, therefore, the purpose of this short address to attempt (1) to classify the types of sterility; (2) to point out some of the chief etiological factors; (3) to suggest methods for arriving at the correct diagnosis; and (4) to correlate and evaluate the present methods of treatment.

Sterility is the inability on the part of the woman to produce a living child, and it may be classified as: (1) absolute, and (2) relative.

Absolute sterility is a condition in which impregnation is obviously impossible because of such defects in the genital apparatus that either the avenues of transit or the organs of reproduction are absent or defective.

Relative sterility may be either (a) primary or (b) secondary. When of primary origin the woman does not conceive under normal conditions during the first few years of married life. This may be due to such idiopathic conditions as fetalism, infantilism, and endocrinal deficiencies. Arbitrarily, a woman is considered sterile when no contraceptive measures have been employed, if she does not conceive within 17 months of married life.

Secondary sterility is usually acquired and is most frequently the result of birth traumatism or infections following upon childbirth or gonorrhœa.

In the consideration of any case of barrenness in a woman, the physician must remember that there are five basic requisites to conception and the healthy development of the ovum.

1. Healthy, active spermatozoa (having "progressive vibratile" motion) deposited by coitus in the posterior fornix or on the cervical portio.

2. A perfectly matured ovum.

3. A patent tubo-uterine tract which will allow the free transit of the spermatic particles to the outer third of the tube and permit the passage of the fecundated ovum to its final resting place in the uterine mucosa.

4. A normally developed corpus with its progressive changes which control the nutrition and the development of the ovum.

5. Normal secretions in both man and woman with biochemical reactions which are compatible.

It is, therefore, evident that defects in one or more of these primary requisites will prevent conception. It is also a fact that there must be two contracting parties in the consideration of every case of sterility, namely, the male and female.

In this symposium fertility and sterility in the male have been considered by a master in urology. I will, therefore, in my discussion take it for granted, though it requires much imagination, that the male is perfect, for my own studies confirm those of Naggaroth who claimed that between 10 and 15 per cent of all marriages are sterile, and 50 per cent of these barren unions are due to gonorrhœa; furthermore, that about 90 per cent of sterile women are married to men who have at some time had a neisserian infection.

ETIOLOGY

Having excluded the *male as a causative factor*, conception should occur if the healthy "vibratile" spermatozoa have access by uninterrupted transit to the mature ovum. Unfortunately, however, developmental defects in the woman *prevent this in about two-thirds of the cases*—for example, there are many points in this avenue of transit which may interrupt the normal progress of the spermatozoan; such as malformations of the vagi-

[1] Presented before the Clinical Congress of American College of Surgeons, Montreal, October 21-25, 1926

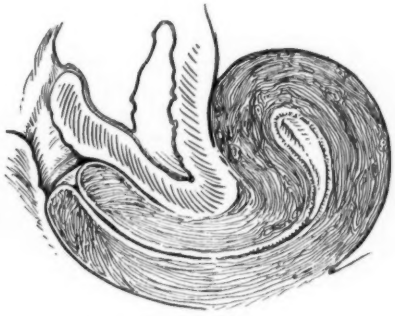

Fig. 1 (left). Acute antiflexion of the cervix. External os out of the seminal pool.
Fig. 2. Intravaginal hypertrophy of the cervix which has a piston-like action upon the deposited semen.

nal orifice, or of the external genitals, or congenital anomalies of the vagina instanced by imperforate hymen, rudimentary vagina, infantilism or partial or total absence of the genital organs, or faulty cervical invagination which appears in the form of the long conical cervix with its "pin-hole" os, or cervical anteflexion with its short anterior and deep posterior invagination with retroposition of the entire organ, or retroversion of the uterus, or infravaginal hypertrophy of the cervix. All of these conditions make conception mechanically difficult, for they may interfere with the successful consummation of the sexual act by allowing the escape of the deposited semen by the piston-like action of the uterus in the vaginal tube; or their existence allows the spermatozoa to die before reaching the security of the cervical canal, for all of the above anomalies efface the seminal pool.

Congenital anomalies are not alone confined to the vaginal cervix but may be evidenced in malformations of the uterus, excessive length and tortuosity of the tubes and the absence or hypoplasia of the ovaries. It is seldom, however, that the presence of these developmental arrests is not suggested by the *study of the stature and the endocrinal markings of the particular individual.* Furthermore, these developmental defects do not occur alone as a single entity. They are rather a part of the whole scheme of nutritive and endocrinal deficiency or unbalance. Hence every case of primary sterility should be studied along these lines, i.e., is there a congenital anatomical defect, or is there an endocrinal deficiency or unbalance shown by the developmental changes which are present or absent controlled by the action of these several glands of internal secretion.

In the study of the secondary sterility which is usually acquired; trauma, infection, and displacements are the chief etiological factors. Under trauma may be considered: (1) the relaxed vaginal outlet with its various degrees of descensus which fail to retain the ejaculated semen; (2) the lacerated cervix with tears extending through the external os and into the parametria which so distort the anatomical relations of the vaginal vault that should conception occur, abortion is the rule; (3) the retroverted subinvoluted uterus with its hypertrophied endometrium which offers but an uncertain site for "embedding of the ovum."

The most common seat of pelvic infection is primarily in the cervix (endocervicitis) and here it is apt to become chronic with a more or less far reaching pathology. Endocervicitis or cervicitis may be of either neisserian or septic origin, and all observers agree that the cervix is the most frequently attacked point in gonorrhœa in the married or parous woman. Because of the peculiar gland and lymphatic arrangement in the cervix, the infection involves the deeper gland structures and so alters the character and tenacity of their secretion that the cervical os becomes plugged with a mass of tenacious mucopus which offers an impregnable obstacle to the

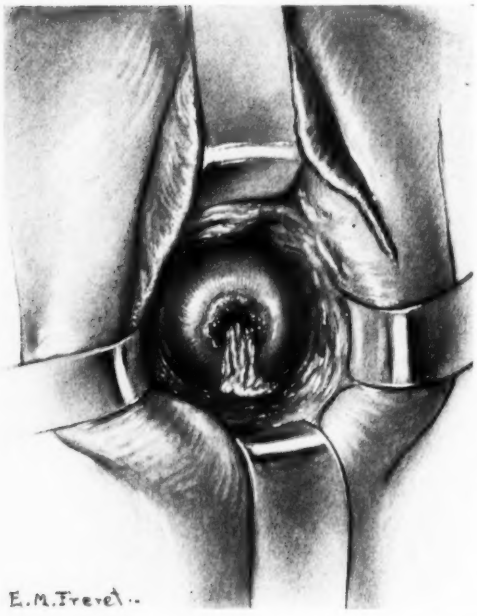

Fig. 3. Chronic endocervicitis with ropy mucopus blocking the os.

upward advance of the spermatozoa. Fortunately, cervical gonorrhœa remains a local infection unless the primary infection occurs at or near the menstrual period; unless it is carried up past the internal os by the physician in attempts at over-treatment or by dilatation, or the introduction of a stem pessary, or by curettage after an abortion, when it usually becomes a mixed infection which involves not only the cervix and its glands but extends to the endometrium and tubes, or by the contiguous lymphatics through the parametria to the pelvic peritoneum exciting therein a perisalpingitis and peri-oophoritis. The history of gonorrhœal infection always suggests the possibility of a sterility due to a cervical or tubal pathology; while the story of curettement, abortion, or postpartum or postoperative infection suggests parametrial extension with peritubal and peri-ovarian involvement. The former is always bilateral, while the latter may involve only one side; instanced in the cases of perisalpingitis following appendicitis.

Other uterine lesions which may prevent conception, are intramural and submucous tumors, for there can be no doubt that miscarriage is more frequent in the fibroid uterus, as the muscular contractions are more marked and in the development of fibroids in these locations anomalies of the endometrium obtain which in turn may prevent normal embedding of the ovum. Excessive hyperplasia, œdema, atrophy, and hypertrophy of the endometrium, all have their influence on possible conception. In addition to this, cornual tumors may so elongate and distort the tube that impregnation may be impossible.

The last etiological factor to be considered in sterility, is the quality of the ovarian function, for the completely matured ovum is a necessity for conception. It must be admitted that ovarian hypoplasia from one cause or another actually exists, and not only may this defective ovarian function be a result of peri-ovarian inflammation, but according to Rosenow may occur as a sequel of hæmatogenous infection with the formation of microcysts throughout the ovary which produce follicular atresia and prevent or postpone ovulation. The ovary of a fertile woman is of uniform outline which shows not more than one thin walled projecting follicle or corpus.

Fig. 4.

Fig. 5.

Fig. 4. Ovary embedded in adhesions. Tube open but distorted by pelvic peritonitis.
Fig. 5. Microcystic ovary with thickened tissue.

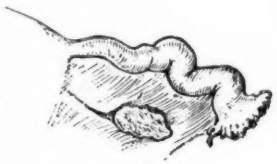

Fig. 6.

Fig. 7.

Fig. 6. Atrophic hypoplastic ovary; no follicles.
Fig. 7. Tubal occlusion as found in endosalpingeal infection.

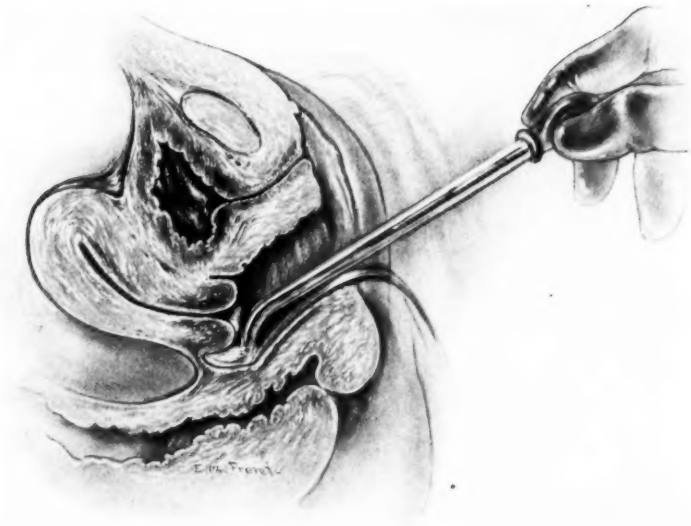

Fig. 8. Huehner test. Recovering the deposited semen from the posterior vaginal fornix, to demonstrate male potency.

OVARIAN FUNCTION

Hypoplasia of the ovaries with microcystic formation or thickened tunic will not infrequently prevent conception; likewise, large unicysts, such as the corpus luteum cyst will not infrequently produce follicular atresia and sterility. This has been shown in cattle. According to Williams, on rectal examination of cows failing to calf, the ovary is found large and cystic and when the cyst is broken by compression, they immediately conceive. Likewise in the human. Rubin, Ronge, and others in this country have stimulated the ovarian secretion and ovulation by very small doses of the X-ray with numerous resulting pregnancies. One interesting point in Rubin's report is that when the ovary was found to be extremely small, atrophic in character, no amount of stimulation did any good. While nine out of his twelve cases had a palpable cystic ovary, under stimulation ovulation was normal and conception occurred.

It would seem, therefore, that these unicystic ovaries in the human are comparable to the enlarged cystic ovary of cattle, which cause atresia and prevent normal maturation of the ovum.

In contrast the ovaries of sterile women show on gross examination numerous thin walled projecting follicles or numerous small imperfect looking corpora or both. They are tense and lobulated in outline, or they may be small and scarred, with no appreciable follicles or corpora, or large and white with a very thick tunic showing no surface projections.

We will not at this time go into the endocrinal deficiencies which play their part in the reduction of fertility and the production of sterility. Suffice it to say that the hypothyroid type woman with a low basal metabolic rate (Litzenberg) may conceive if her thyroid function is activated; likewise, the amenorrhœic fat individual who menstruates either irirregularly, scantily, or not at all, may have her chances improved if the periodicity of her menstruation is re-established. These patients are usually obese and require a reducing diet as well as active thyroid therapy.

DIAGNOSIS

Dr. Edward Reynolds, in his chairman's address before the Section of Obstetrics and Gynecology, 1916, summed up the situation

Fig. 9. Huehner test. Aspirating the intracervical mucus to determine the presence of live spermatozoa.

then and the basic conditions are no different today.

"The failure of mating may be due to any one of the following factors: (a) Absence or deficient fertility of the spermatozoa; anatomical defects of the male organ of intromission; pathological conditions in the male which destroy the spermatozoa bèfore or during ejaculation. (b) Conditions which destroy the spermatozoa after their deposition in the vagina, or entrance into the cervix, uterus, or tubes. (c) Finally, absent or deficient ovulation." Therefore in arriving at a diagnosis as to the cause, the woman should be typed by her stature and her endocrinal markings. This may be done in the course of her complete physical examination. Having settled that she has no marked evidence of hypoplasia or developmental arrest, a pelvic examination may be made to determine the formation of the external genitals, introitus, and vagina, then the size, form, position, and condition of the cervix, particularly to establish the presence or absence of an endocervicitis with its tenacious mucus plug and the reaction of the cervical secretion. These facts having been ascertained, a bimanual pelvic examination is now in order to determine the size, position and mobility of the uterus, the presence of uterine tumors. and the condition of adnexa and parametria. After excluding the presence of gross anatomical deformity or lesion, we may then proceed with a Huehner test, an examination of the vaginal, cervical, and fundal secretions at varying periods of time after coitus, to determine the presence and the condition of the spermatozoa *in situ*.

Observation shows that spermatozoa deposited at the vulva die quickly—those in the vagina and on the portio within a few hours, but when the male element is found within the cervical canal they live much longer. Live, active spermatozoa have been found in the uterus 5 and 6 days after coitus, and in the distal portion of the tube nearly a month after recorded intercourse (Winckle). Apparently, therefore, it is the secretion at or about the cervix which offers the first real

obstacle to the advance of the spermatozoa and subsequent impregnation.

In conducting the Huehner test, the wife presents herself for examination within an hour or two after coitus—if the live spermatozoa are found in the vaginal vault, on the portio, or in the cervix the husband may be absolved from his part in the production of the sterility. The spermatozoa may die at the os or in the cervical canal or they may pass into the uterine cavity. When the spermatic particle is found alive at the fundus the cause of the sterility must necessarily be in the tubes or in the ovary.

Until recently we have had to depend upon a history of a previous infection, or abortion or curettage to determine the probable patency of the tubes. In 1910 Cary showed that it was possible to demonstrate the patency of the tubes by injecting them with a solution of argyrol and having them X-rayed.

In 1919 Rubin demonstrated that it was possible to pass oxygen or carbon dioxide gas through the tubes under low pressure and if the tubes were open to produce a pneumoperitoneum. By these methods one can definitely demonstrate the patency or impatency of the tubes. Aside from its diagnostic significance, insufflation in properly selected cases aids the sterile woman:

1. "By establishing the patency of the genital tract from the external os to the abdominal opening of the fallopian tubes. Any cervical canal that is patulous to the uterine cannula used in uterine insufflation is ample for the entrance of spermatozoa. If the external os appears punctate or pinpoint but admits the cannula, this is proof that it is wide enough to allow semen to enter the cervical canal."

We have the records of many cases in which conception has followed upon insufflation.

2. In some cases a mucus plug not visible at the external os but occupying the deeper portion of the cervical canal is seen to be expelled after the insufflation, on the withdrawal of the uterine cannula.

3. By separating mild agglutinations of the folds of the tubal mucosa, by straightening out tortuous tubes especially of the infantile type, by dislodging inspissated mucus from a narrow to a wider portion of the tube, by actually separating adhesions at the fimbriated end in cases requiring 150 to 200 mm. Hg. opening a way for the descending ovum to meet the ascending spermatozoa.

Fig. 10. Rubin apparatus complete.

4. Still another factor not to be lost sight of is the psychic impression which periuterine insufflation makes on the patient. Although the exact nervous mechanism is not at present clear, there are women who respond to the physical stimulation of periuterine insufflation through the psychic acting upon the autonomic genital apparatus. Whether it indicates a certain amount of relaxation in otherwise spastic tubes, or of the uterine openings, must await further inquiry. That there actually exists in certain tubes, spasm sufficient to close the uterine ostium in a manner similar to the closure of the internal os of the uterus has been recently demonstrated by both Rubin and Kennedy.

Indications for periuterine insufflation are given by Rubin as follows:

1. Primary sterility, in which contributing causes, including those for which the husband might be responsible, have been eliminated

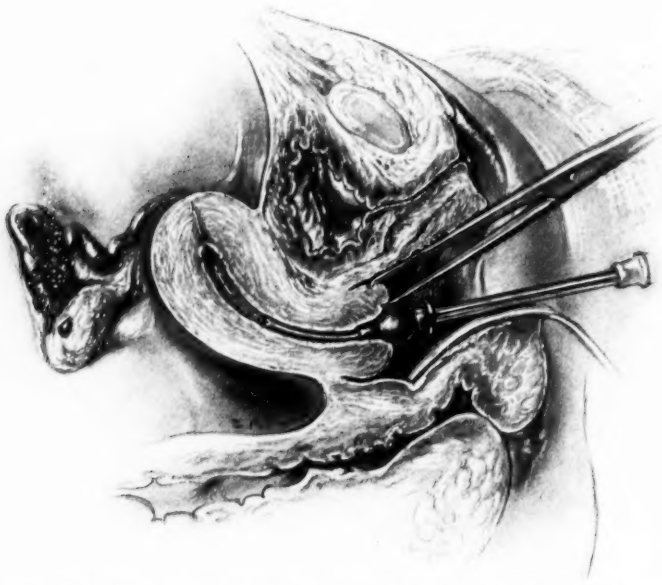

Fig. 11. Rubin test. Cannula in place, gas escaping from the fimbriated end of the tube, demonstrating uterotubal patency.

and some operative procedure is contemplated. Here it has a definite prognostic as well as diagnostic value.

2. Primary sterility in which the patient is known to have passed through a gonorrhœal pelvic infection soon after marriage and is at the time of the inquiry free of pelvic symptoms.

3. Sterility following a pelvic exudate or abscess complicating a puerperium or abortion, with or without the history of an operation in which resolution has apparently taken place.

4. Primary sterility in which the patient had peritonitis of appendicular origin in the premarital or postmarital state, to exclude tubal occlusion by peritoneal adhesions.

5. One-child sterility without the definite history of pelvic infection.

6. After the whole tube and part of another have been removed for hydrosalpinx or pyosalpinx (conservative surgery).

7. After unilateral ectopic pregnancy to determine the patency of the residual tube.

8. After salpingostomy to determine the success of the operation which was calculated to effect an opening of occluded tubes.

9. After sterilization by tube ligation to test the patency of the tied or severed tubes.

10. After multiple myomectomy in nulliparа to make certain that at least the uterine ostium of the tube has been left intact.

11. Sterility of long standing in which pelvic masses are palpable and clinically diagnosed as fibroids or "chronic disease of the adnexa." The test shows whether or not the tubes are open.

12. As a therapeutic measure to eliminate the tubal factor in sterility.

Though the causes of sterility are often obscure it appears at least that the mechanical factor of patency should be possible of determination in most cases, and in this way save the woman from the dangers and discomforts of unnecessary operation.

Tubal insufflation and the Huehner test to determine the activity and the life of the male element have placed our treatment of sterility on a more rational basis, and I am glad to note that fewer needless operative procedures are being done and that the results are better than those obtained a few years ago during the period of operative furor.

TREATMENT

From this brief review of the multiplicity of causes which may impair fertility and produce sterility, it is apparent that the treatment in each particular case must be individual and the procedure decided upon only by a careful and repeated study of the potential possibilities of both parties to the marriage contract, for no treatment in any case of sterility should be begun without first having made an examination of the male member of the partnership; for about 30 per cent of barren unions are due to the male.

Having satisfied ourselves that the male member is potent, obstructions to the disposition of the ejaculated semen must be dealt with.

Imperforate or obstructive hymen should be excised.

Those types of dyspareunia due to vaginismus may be relieved by divulsion under anæsthesia, or by lateral sulcal discission of the introitus (these wounds are closed in a direction transverse to the axis of the vagina). The patient should then be taught to wear a Sims vaginal plug at night until the capacity of entrance is assured.

One of the most common results of Huehner tests done upon a large number of women is to find countless spermatic elements alive and active in the vaginal fornix, and dead ones at the external os or in the mucus plug of the cervix. This observation points to abnormal secretion from the cervix as a cause of barrenness.

Normally the mucus secretion of the cervix is stimulated by coitus, aids the upward advance of the spermatozoa, and helps maintain the alkalinity of the secretions about the portio. Endocervicitis changes these conditions by altering the quantity, character, and reaction of the discharge.

In our experience endocervicitis has been directly or indirectly responsible for nearly 70 per cent of female sterility, malformations making up the balance.

Where the Huehner test places the responsibility in the cervix, this condition may be remedied by aspiration, cauterization and excision. Before aspiration it is well to smear the cervix and external os with a paste of equal parts of soda-bicarbonate and peroxide of hydrogen which facilitates the removal of the mucus by suction.

When the sterility is due to infravaginal hypertrophy or acute anteflexion of the cervix with deep posterior invagination which may be shown by finding numberless live spermatic particles in the fornix, but none alive or dead on or in the cervix, low amputation or posterior discission after Dudley will place the cervix in the seminal pool. The stem pessary of the Baldwin or Davenport type has a very limited field. It is especially indicated in the small conical cervix with slight invagination or the anteflexed body, where the sound shows that the uterus is of the infantile type. *A stem is absolutely contra-indicated in the presence of endocervicitis of any type or origin.* Gradual dilatation with the Hegar dilators to 20 to 25 millimeters should precede the introduction of the stem; while pituitary extract and corpora lutea extract given hypodermically during the period that the stem is worn has seemed to add to its efficiency.

Repair of the pelvic floor will be helpful in those few cases of secondary sterility in which the semen which has been ejaculated is not retained.

Sterility associated with myomata in the body of the uterus justifies the removal of the tumor or tumors by myomectomy, while uterine displacements may be corrected by reposition and retained in normal position by perfectly fitting pessaries or properly selected operation in those cases of normal introitus in which the semen is expelled by the piston-like action of the displaced uterus. Angulation of the tubes may be corrected by plastic operations; while occlusion of the tubes in which there is no infiltration of the tube wall may be remedied by reopening the abdominal ostia (salpingostomy) which is successful in about 7 per cent of the cases. Hystero-salpingostomy or resection of the tube from the uterine cornu and implantation of the healthy portion of the tube into the uterus, gives a larger percentage of success. Decapsulation of the ovary allows follicular development, in those cases in which the tunic is thickened and the surface follicles are absent or multiple.

In bilateral hydrosalpinx, pyosalpinx, or severe chronic salpingitis, there is practically no hope from operation.

The endocrinal hypoplasias are all improved by the hypodermatic employment of the deficient endrocrines combined with diet, exercise, and sunlight. This is particularly true in the hypothyroid type with low basal metabolism.

CONCLUSIONS

In conclusion, let me say that there are many unsolved problems in this interesting subject, and with all we have learned most of our cures are by accident or are incidental for there are psychical and biochemical factors in the consummation of the marriage act that can and do prevent conception in the anatomically perfect.

THE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR

By D. P. D. WILKIE, F.R.C.S. (Edin. & Eng.), F.A.C.S. (Hon.), Edinburgh, Scotland
Professor of Surgery, University of Edinburgh

SINCE Whitman demonstrated that abduction was the essential factor in the treatment of fractures through the femoral neck and that by efficient abduction union might be anticipated in a very high percentage of cases, various methods have been practised to attain this end. That most commonly used is the plaster case enclosing the damaged limb, the pelvis, and the sound thigh, maintaining abduction at both hip joints. In elderly subjects the immobilization by such a necessarily large and weighty casing is always irksome and sometimes dangerous, and, unless a constant watch be kept, may lead to pressure sores. When we consider what are the bare essentials in the treatment, we find that there are really only two, namely (1) to keep the limb fully abducted and thus to jamb the distal fragment against the short proximal one, and (2) to correct the eversion of the limb. To maintain abduction the pelvis must be kept from tilting, and this can be done only by abducting the opposite limb. It is quite unnecessary to immobilize the hip joints, as, if the two fragments are actually in contact, movement at the hip will certainly take place very much more readily between the smooth articular surfaces of head and acetabulum than between the rough fractured surfaces which are more or less interlocked.

The following simple method appears to meet the above indications without embarrassing the patient as does the pelvis-enclosing plaster case.

To the limb on the affected side a cotton-wool bandage is applied, enclosing the foot and extending up to shortly below the knee.

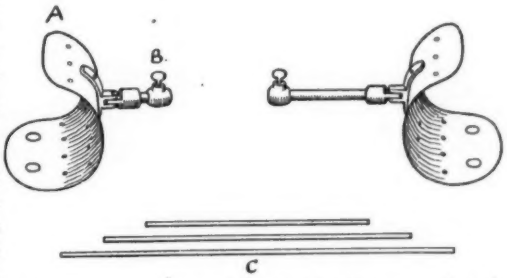

Fig. 3. Apparatus consisting of flexible copper sheet A, with jointed attachment B, which is tubular to receive brass abduction rod C.

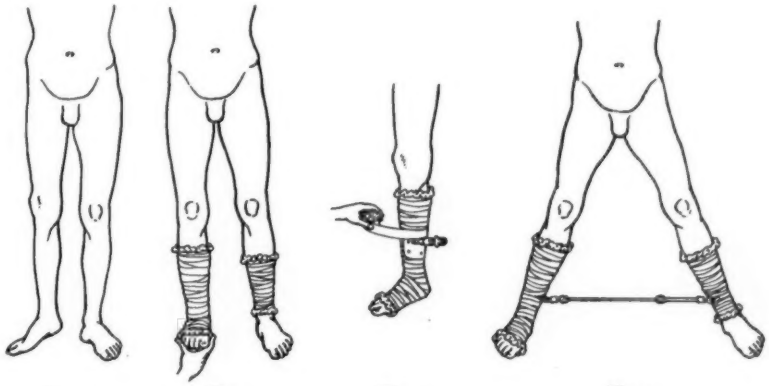

Fig. 1. Fig. 2. Fig. 4. Fig. 5.

Fig. 1. Position of limb before treatment.
Fig. 2. Cotton wool and preliminary turns of plaster bandage applied.
Fig. 4. Incorporation of apparatus in plaster case.
Fig. 5. The abduction rod has been inserted and the eversion corrected.

Over this a plaster-of-Paris bandage is applied (Fig. 2). The limb is then rotated inward until the toes look forward, and Part A of the apparatus is applied to the plaster case just above the ankle in such a way that the metal arm lies parallel to the bed with the toes looking forward (Fig. 4). Another plaster bandage incorporates the metal cuff in the plaster case. Over cotton-wool a short cuff of plaster is applied to the sound limb just above the ankle and Part B of the apparatus incorporated in this. The two limbs are now abducted and a light brass bar of suitable length is inserted into C and D to maintain abduction (Fig. 5). After a few days, a window may be cut on the outer side of the plaster cuff on the sound leg to permit of the latter being exercised.

The pelvis being quite free, moving is simplified, and it is unnecessary to restrict movement at the hip joints. The patient may be set up in bed and may move the trunk freely. The results obtained by this method so far, namely in 7 cases, have been excellent.

The apparatus is easy to construct, is light, readily transported and inexpensive.

THE BALDWIN OPERATION FOR THE FORMATION OF AN ARTIFICIAL VAGINA

Report of Six Cases

By Dr. SERGEY JUDIN, Serpouhoff, Russia (U.S.S.R.)
Surgeon of the Industrial Hospital in Serpouhoff

THE operation of forming an artificial vagina is most often done for the correction of congenital aplasia of this organ. A simpler plastic operation will suffice in cases of moderate atresia but in cases in which more extensive destruction by childbirth has caused almost the entire obliteration of the vaginal canal complicated in most cases by fistula of the bladder and rectum, the treatment is much more complicated than simply operating to restore the vagina, the remains of which often serve to cover defects of the neighboring organs. In the course of successfully closing such fistulæ, the surgeon sometimes finds it possible to form a new vagina.

Such a problem was successfully solved by Professor Kakuschkin of Saratov. There was an after-birth defect of the front wall of the vagina consisting of a vesico-uretero-vaginal fistula which permitted the entrance of 3 fingers. The closing up of the fistula, the formation of an artificial vagina by the Schubert method, and the removal of some operative defects required 7 operations some of which were done under chloroform plus ether and some under intravenous hedonal anæsthesia, extending over a period from July 9, 1919, to June 9, 1923. At the end all was well and the patient could marry again.

In the ideal operation, the artificial vagina would be sewed into the uterus and pregnancy made possible. Up to this time, I know of no one who has done such an operation. This is due to the fact that the cases operated on were not of gynatresia but of complete congenital aplasia of the vagina, which as a rule is associated with complete aplasia of the uterus as well. The explanation of the absence of both organs is found in a study of the mechanism of their embryological development.

As we know, the vagina and the uterus develop from the union of both muellerian ducts, which, lying on the ventrolateral surface of the wolffian body at the caudal end of the embryo and entering the pelvis minor, remain for some time parallel to one another within the ligamentum inguinale. The union of both muellerian ducts normally begins on the front of the tail and the middle third of the ligamentum inguinale and finally forms the uterovaginal canal. This union begins in the

second month of intra-uterine life (O. Hertwig), and the point where the two muellerian ducts first unite corresponds to the top of the future external uterine orifice. The parts of the muellerian ducts above this point remain separate and ununited and become the salpinx; those below this point fuse and become the uterovaginal canal. The differentiation of the latter begins much later; the individuality of the uterus and the demarcation of it from the vagina begins more definitely only during the sixth month when the top part becomes a muscular wall, a projecting ring-like cylinder organizes a portio, and the lower part—the future vagina—remains capacious and retains its walls.

The vagina and the uterus develop from the same elements of the embryo, and for from 2 to 6 months remain undivided one from the other. So that if some anomalous or disease process results in non-union of the muellerian ducts the uterovaginal canal is not formed and the woman is born not only without a vagina but without a uterus as well. If the development of the upper parts of the muellerian ducts is normal they become fallopian tubes and descend with the ovaries into their places.

In 8 cases (6 of my own here mentioned, 1 of Dr. Holin's, and 1 of Dr. Atabekov's), I have confirmed by laparotomy the complete absence of the uterus and vagina. Each time the picture was the same, the cause of the deformity evidently being the same. In all cases the women were of the decidedly feminine type, with entirely normal exterior genitalia, tubes, and ovaries but with complete absence of the uterus and vagina. It was quite clear that during the embryonal period there was no union of the muellerian ducts and no formation of the uterovaginal canal.

When coming to the question, as to which cases should be operated upon, we might ask whether a woman should be provided with an organ which clearly cannot serve for giving birth and is suitable only for coitus. In different countries this question has arisen and has been hotly debated, especially after the report of the first operation done by Snegirev in which the rectum was used to form the vagina. But, whatever arguments were brought up by the opponents of the operation they proved inadequate when the surgeon was faced by a patient who threatened to commit suicide if the operation was not performed. Two of my patients contemplated suicide unless the defect could be corrected. That this has been the position of many surgeons in years past can be judged by the many attempts which the history of surgery has kept for us. In the work of A. Paunz (4) and in the manual of Doederlein-Kroenig (2) one can find much discussion on this subject.

To Dupuytren in 1817, Villaume in 1823, and Amusat in 1832 belongs the honor of the first attempts. They made a passage between the bladder and the rectum. Of course, as such tissue was not good plastic material these attempts led to nothing. Sarwey and Stande tried to secure exterior epithelization by holding back the edges and all the wounded surface of the opened passage by a dilator. The transplantation devised by Thiersch was tried by many surgeons such as Abbe, Credé, Anderson, Czempin, Forgues, Isaac, Sitsinsky, Flemming, Pfannenstiel, Tuffier, and Pozzi. All had poor results except Pozzi who obtained a fair result in 1 case after using a bougie daily. Heppner tried to move a flap from the skin of the thigh and labia majora, but Bumm after transplanting the skin from another place had such a growth of hair that he had to cut the flap back again and operate a second time by the Baldwin method. Bumm's idea was to transplant to another the mucous membrane of the vagina from a patient being operated upon for prolapse of the uterus and vagina. This was tried by Kuester and Mackenrodt but without success. Ott, Stoeckel, and Kroener tried to use the Douglas peritoneum; Dreyfus, the hernia sac.

In addition to these, different methods have been devised for forming an artificial vagina from intestinal material. Gersuny in 1904 and Feodorov in 1906 used the front wall of the rectum. Baldwin in 1904 proposed the use of a section of the sigmoid flexure. In the same year Snegirev used the whole lower part of the rectum in 4 cases, making an anus sacralis. Popov removed the ampulla of the rectum, preserving the sphincter, and up to 1914 had performed the operation with success in 5

cases. Gersuny, Amann, and Schubert later followed Popov's idea. Schubert changed Popov's method somewhat, and now in the German literature it is called the Schubert operation. It was further changed and simplified by Strassman.

The Baldwin operation was not left without changes and improvements, though it retained the principle: the making of an artificial vagina from the mesentery of the intestines, well provided with blood vessels.

Mori of Tokyo in 1908 formed the vagina from a part of the jejunum, lowering one part of it. Haberlein in 1907 and Stoeckel in 1912 did the Baldwin operation by the American method, using not the colon but the jejunum. Since then the Baldwin operation has been done in this way and is more and more successfull competing with the method of Popov-Schubert.

The comparative and statistical value of the two methods we shall give at the end of this article, but we can speak authoritatively only of the Baldwin operation which we used in all of our 6 cases.

This operation must be done through a laparotomy incision. The approach cannot be made from the perineum. It is easier and less dangerous to make a passage through the cellulosa between the rectum and bladder; and only after laparotomy can one decide whether the patient can be operated upon successfully. Success depends upon whether or not a part of the intestine can be found which can be pulled up to the level of the perineum without stretching the mesentery. This is a question of great importance and is the principal factor in the success of the operation. In our cases the mesentery was broad enough; but we believe that should it be impossible to find a piece with a sufficiently wide mesentery, an operation similar to that used by Roux-Gerzen (the Mori operation) for the formation of an artificial œsophagus could be performed. In this operation the edges of the mesentery are mobilized. But we know of some cases in which there was such a narrow mesentery that the operation either could not be completed or it ended in a catastrophe because of a stiff intestine. In one of our cases we mobilized one edge of the mesentery with the result that partial necrosis was followed by the falling off of the stiff mucous membrane. In the end the patient had a good vagina, but one cannot deny that the risk of peritonitis had been great.

How should we deal with the mesentery? How much must we cut off the edge of the resected piece. Of course there is no necessity for making deep cuts and therefore having to ligate large transverse vessels. Besides this the slits that happen to be made in the mesentery in deep incisions may in time be the cause of incarceration and obstruction. That these are not theoretial guesses but real facts one may judge by the following cases:

Wallerstein's patient, 5½ years after the Baldwin operation, had ileus, but asked for help only after 3 days and consequently died. Strobansky's patient, 2 years after the Baldwin operation, had ileus because of the incarceration of the jejunum at the edges of the cut mesentery. This patient was immediately operated upon in the clinic of Professor Hesse of Leningrad and became well. The history was loaned me by Dr. Sokolov, the assistant at the clinic. When Hesse saw this patient, she had already been operated upon by Professor Petrov twice for ileus since the operation for an artificial vagina had been performed.

On the other hand it seems to us that there is no special necessity for leaving the mesentery entirely uncut as Constantine (1) of Algiers recommends. Being afraid to injure the vessels he cuts only the intestine and having sewed up all of the four ends, restores the intestine by a side antiperistaltic anastomosis so that when the two intestines come together they form a spear. The fate of the resected piece of intestine depends on the width of the mesentery which cannot be made longer in this manner. Therefore there is no necessity for using such an imperfect method of anastomosis.

When choosing the intestinal loop, one must be guided by the width of the mesentery and the supply of good arterial trunks. It is quite natural to choose the piece so that in the middle of the mesentery of the loop there will be a large arterial trunk which will give blood to both sides of the looped mesentery. This is a

wrong calculation. It is much better to choose a piece in which the feeding vessels are smaller but lead to the free edge of the mesentery. After the intestine is sutured to the opening in the vulva, the middle part of the mesentery will be strained the most, the free edges the least. If the principal feeding vessel passes through the middle of the mesentery, the entire loop will be badly nourished when under strain and it may stiffen. If the principal vessels are near the edges, which are never strained very much, blood can flow from both sides however great the strain on the middle of the mesentery. I consider this a very important feature of the operation, and in all my operations have watched this point.

Some words as to how to make a passage between the rectum and the bladder. The peritoneum is opened by a horizontal incision parallel to the lower border of the bladder, the area of the incision being held taut by two pairs of forceps. Very often the line of the proposed incision is marked by a compact trace which goes across the Douglas peritoneum beginning at the median ends of the fallopian tubes. The direction through this porous cellular tissue must be carefully chosen so that neither the intestine nor bladder is disturbed. It is best to keep near the bladder because damage to this is less dangerous than damage to the rectum; though to sew up the bottom of the bladder in an area deprived of peritoneum is very difficult, much more difficult than to sew up the front wall of the rectum. If, in deepening the incision, we soon come upon the wall of the bladder, this means that the incision is too far toward the front and not in the deepest part of the Douglas peritoneum. Then it is better to sew up the incision and begin again in the right place.

When the passage is deep enough for a finger to be inserted into the urogenital fissure from the interior to the unopened exterior covering, the latter is cut through. This cut must be made evenly, with one movement of a very sharp scalpel; because if we have scratches or tears, the patient always complains of great pain when the drains are changed.

As soon as the passage is made, a threefold rectal retractor is put from the outside through the urogenital fissure, and with its help the opening is pushed apart. The parted branches of the instrument are fastened by a screw and the opening firmly tamponed with muslin napkins for complete hæmostasis. These tampons are kept in place during the entire operation on the intestines.

What should be the length of the piece of intestine to be cut out? To a certain extent the length will depend upon the position and size of the vessels of the mesentery. It is best to take a loop that is not too long, as there may be a profuse secretion of the mucous membrane, and a constant secretion of mucus results in great discomfort. Usually a piece 20 to 30 centimeters in length is removed, but I think it should not be longer than 20 centimeters. This will be quite enough, and there ought not to be much secretion. The intestinal canal may be restored by any method. In 1 case we made a side isoperistaltic anastomosis of the closely sutured ends; in 2 cases an ileocæcostomy end-to-side; in 2 cases the ends were sutured end-to-end. In all cases the anastomosis was made with one row of interrupted silk sutures.

The ends of the resected piece I did not suture closely as did Baldwin, though I followed his method on the whole. But I sewed the ends together so that I had a hollow closed intestinal ring. I prefer this method because (1) we have no sac blind at each end in which mucus and semen may gather and decay and inside which such secretions can move peristaltically; and (2) it is easy to take douches, as into whatever passage the nozzle is introduced, the water having cleansed the intestine will come out at the other end. This is of great importance for the welfare of the patient, but is of especial importance for the first few days after the operation, since in the absence of high pressure, one can begin the douches early and not be afraid of injuring the sutures of the anastomosis. When the anastomosis is finished, the middle of the mesentery is pricked through with a thick needle near the edge of the intestine and a thick silk cord is passed through. With the ends of this cord the intestine is dragged up to the level of the opening of the vulva and the wall of the intestine is carefully sutured to the edges of the opening by separate catgut sutures.

In all my cases I burned the opening in the intestine with the Paquelin cautery on the third, fourth, and even the fifth day, when the tissues had started to unite. From the standpoint of asepsis this is of course very profitable, but has its disadvantages. After the first few days the cautery has a tendency to go deep and to form in the vulva a funnel in which the swollen ends of the catgut sutures stick out, obliterating the wall of the intestine. Ether anæsthesia is necessary because when the cautery approaches, the patient compresses the perineum so much that neighboring organs are easily burned. This happened in a case reported to me by a surgeon; the rectum was burned through and a fæcal fistula resulted.

To approach the intestine and better uncover the field of operation, I drew loops of silk sutures through the bases of both labia minora so that the bottom of the funnel could be drawn up and simultaneously the labia minora drawn apart. These threads were passed through beforehand during the operation.

The second disadvantage of opening the intestine later is that during a second operation we do not quite approximate the edges of the incision of the vulva and the result is that it causes great pain to dress the wound and to change the drains. I believe it is best to open up the intestine at once, for we can then suture the twisted mucous membrane again and completely cover the surface of the wound.

I performed all operations under spinal anæsthesia which I consider the best method for these operations. To facilitate the passage between the intestine and the bladder, we must have a space in the vacant pelvis minor and a soft abdomen. Spinal anæsthesia assures these, and as the patients are young, healthy women, the dosage of alcaloid can be comparatively large, 2 to 2.25 cubic centimeters of a 5 per cent novocain solution. If this amount does not maintain anæsthesia to the end of the operation, one can either repeat the injection to the abdominal cavity through the cartilage of the fifth lumbar vertebra or give ether. Of course, when the spinal injection is repeated, the dosage must be reduced one-half or even more.

I will give briefly the histories of my cases.

CASE 1. E. K., 22 years old, 6 months ago married and had libido. Coitus was not successful. The external genitalia were quite normal and the patient was a well expressed feminine type with the secondary sexual characteristics well developed. There was no vagina, and two-handed examination by the Kelly method showed complete absence also of the uterus. Besides this there was a congenital lack of development of the left eye with which she could not see anything.

May 24, 1923, operation was performed. Spinal anæsthesia was induced with 2.2 cubic centimeters of a 5 per cent solution of novocain. The laparotomy incision was made in the inferior median line with the patient in a sharp Trendelenburg position but with flexed and abducted thighs. The patient was supported by the shoulders, but she also held on to the edges of the table to keep from slipping off head downward.

Well developed tubes and ovaries somewhat larger than normal were disclosed. There was no sign of a uterus except perhaps two fleshy pieces each the size of an almond at the median end of each tube. A parietal incision of the peritoneum was made in a transverse direction parallel to the bottom of the bladder. The forming of the passage was very difficult and for control a metal catheter was introduced into the sinus. After great effort we reached the vulva itself. Then by stretching the outer skin with forceps we were able to make the incision on the exterior surface.

Through this skin incision, forceps were introduced into the pelvic cavity and we began to deal out the intestinal loop at a point 25 to 30 centimeters from the cæcum. A piece 35 to 40 centimeters in length was chosen. At the proximal end the mesentery was cut vertically for about 4 or 5 centimeters, and at the distal end obliquely; so that at the foundation the resected portion of the mesentery was narrow and at the distal end it became much broader. The principal feeding vessel passed near the proximal end of the mesentery, but after the mesentery had been cut and the ends sutured, the pulsation could be definitely noted to the farthest free edge. Both ends of the resected piece were closely sutured and the ends of the threads near the distal end were left free for bringing it out to the exterior. The integrity of the intestine was restored by a side anastomosis.

In exerting traction on the end of the sutured intestine the thread broke and the second attempt to insert the forceps was unsuccessful. After many efforts we had to seek a more suitable place to bring down the loop and in making the new incision the bladder was wounded. Repairing the wound in the bladder proved very difficult but it was done successfully. After this a passage was found and the intestine was drawn up and sutured in place, the abdomen was closed and an indwelling catheter inserted. No complications followed, and the wound healed by primary intention. The end of the resected

intestine was undone in 24 hours and in 2 more days the protruding edges of the intestine were cut off. On the fifth day a purulent secretion passed from the intestinal cavity and for the next 5 days a considerable quantity of mucous membrane came out with the pus. Douches were given daily and vaseline was poured in through 3 thick rubber drains placed one near the other. At the end of the second week the purulent secretion ceased and the entrance was daily widened by a Hegar dilator until a No. 22 bougie could easily be passed. In 5 weeks the patient went home with a well cicatrized and restored intestine. When examining with the finger one could not reach the interior sutured end of the intestine. The examination was painless. The patient was allowed to begin coitus but had to wear a thick rubber drain between times. It happened that she took the drain out very soon after coitus and for a whole week afterward she could not put it back again. After dilatation by means of bougies for 2 days it was easy to widen the opening and to put the drain back in place. In a month she took the drain out and began normal sexual life. All is well and both husband and wife are content.

I saw the patient not long ago, 3 years since operation, and the vagina is good and she is quite happy.

CASE 2. M. Sch., 21 years old, 9 months married, found coitus quite impossible. The patient was a normally developed woman with all the feminine characteristics. The external genitalia were normal, but there was no uterus nor vagina. She begged for help and seriously thought of suicide.

October 11, 1923, the Baldwin operation was done. The patient was placed in the Trendelenburg position with flexed and abducted thighs on supports. She held herself on the table. Spinal anæsthesia was induced with 2 cubic centimeters of a 5 per cent solution of procaine. At laparotomy we found well developed ovaries and tubes with fimbriæ at the exterior ends and rudiments of uterine horns at the median ends. The passage between the bladder and rectum was located without difficulty through a transverse incision of the peritoneum in the very depth of the cul-de-sac of Douglas. The introitus was lifted outward and a transverse incision marked. Through the incision in the introitus the tissue was bluntly divided, and soon we could enter into the passage which had been made from the inside. Then the canal was widely opened by a threefold rectal mirror and tightly tamponed with muslin napkins. The part of the intestine selected was that nearest the cæcum as the mesentery was thickest at this point. End-to-side ileocæcostomy was done. The piece of intestine was bent double after it had been closely sutured at both ends. The surfaces of both genu which were in contact were sutured together by separate interrupted sutures. The loop of intestine was drawn by a thread into the opening in the vulva and sutured in. The abdomen was closed in three layers. Convalescence was uneventful. The intestine was opened by a Paquelin cautery in 4 days and two rubber drainage tubes were put in. The mucous membrane of the intestine was bright red. The patient went home at the end of a month and after another week began coitus, which is quite painless.

I examined my patient 2 years after operation. The entrance into the intestine lets in easily 3 fingers; deeper one can feel a spur which easily moves aside and is no hindrance to coitus. The mucous secretion is so slight that the patient does not use a douche.

CASE 3. E. Z., 30 years old, came to me for help, as her second husband was sending her away because of the impossibility of coitus. In the depth of the vulva there was only a funnel 1 to 1.5 centimeters deep. There was neither uterus nor vagina. In every other way the patient was of the well expressed feminine type.

November 8, 1923, operation was performed under spinal anæsthesia induced with 2.2 cubic centimeters of a 5 per cent solution of procaine. At laparotomy the absence of the uterus and vagina was confirmed. The ovaries and tubes were well developed and were situated at the sides of the pelvis. The broad cul-de-sac of Douglas was quite empty. The passageway between the bladder and rectum was successfully made by blunt dissection without difficulty. A piece 40 centimeters long from the lower end of the jejunum was resected. All 4 ends were sutured in pairs, end-to-end, so that we had a closed intestinal ring. The piece was drawn out by a thread passed through the mesentery and was drawn to the opening prepared opposite to the anastomosis. Here the intestine was sutured in with 8 catgut stitches. The abdomen was closed and the wound healed by primary intention. The intestine was opened with the cautery on the fifth day. Two rubber drains were put in, and about 200 cubic centimeters of transparent liquid came out. The mucous membrane was red and velvety. The next day douches were given, the water passing through the entire intestine and coming out at the other end. After a week of bougies a 2 centimeter drain was put in and the patient went home.

She came to me several times afterward complaining of great mucous secretion. The introitus easily let in two fingers. A soft spur could be felt at the end of the opening but it did not hinder coitus. The phlegm flowed periodically, several times a day, about a tablespoonful at a time. The patient wears a band to protect her linen. The skin of the thighs and vulva shows no sign of irritation or eczema.

CASE 4. A. Z., 25 years old, was not married, but knew of her defect and asked to have it corrected by operation. I operated upon her June 15, 1924, in the presence of my teacher, Professor Goubarev of Moscow University. He was interested in this operation and came to me at Serpouhoff. The operation was done in 1 hour 45 minutes. Spinal anæsthesia was induced with 2 cubic centimeters of a 5 per cent solution of procaine. The anatomical picture was the same as that in the other cases.

Passage was easily made from the interior to the exterior without damage to neighboring organs.

The intestinal loop, 25 centimeters in length, was taken from the lowest part of the jejunum, and the defect was repaired by an end-to-side ileocæcostomy. The section of intestine was sutured end-to-end. The intestine was opened with a Paquelin cautery on the fourth day. The postoperative course was ideal and the patient went home on the twelfth day. This patient soon married and is quite happy. She came several times to be examined complaining of a mucous secretion which sometimes flows out unexpectedly in quantities of about a tablespoonful, but this does not happen every day. The introitus easily lets in two fingers; the mucous membrane is red and moist. There is a spur, but it is soft, easily moved to either side, and does not hinder coitus.

Case 5. E. Z., 23 years old, fifth year medical student, married one year, was operated upon in the gynecological clinic of the First Moscow University. The invitation to operate was extended to me by the director, Professor M. S. Malinovsky. The patient understood all the dangers of the operation, as she herself was to become a doctor in a few months and she had read all the available literature on this subject. As during the two-handed examination through an exceedingly fat abdomen one could feel per rectum a large tumor, we considered the possibility of a hæmatometra and a second operation for forming an artificial vagina. When I informed my patient, she answered that she was willing to have three laparotomies if only she might become a woman.

November 3, 1924, operation was performed under spinal anæsthesia induced with 2 cubic centimeters of a 5 per cent solution of novocain, 55 minutes, and chloroform 7.0, 1 hour, 30 minutes. At laparotomy the tumor was found to be a cyst of the right ovary, the size of two fists, which was removed the usual way. The tube was left. The left ovary and tube were normal. No uterus or vagina was present. A passage was made between the bladder and the rectum from the interior to exterior. To accomplish this, it was necessary to bring the fingers to meet one another. The passageway was made without much difficulty.

A segment 30 centimeters long was taken from the jejunum at a point 8 to 12 centimeters above the cæcum. The mesentery was long enough so that the edge of the loop could be drawn to the outside. The ends were sutured end-to-end. The suture in the intestine was opened by cautery on the fourth day and two catheters were put in. On the first evening the temperature was 39.2 degrees C., and remained almost normal for a week. On the first two days the patient vomited several times, and had diarrhœa on the fifth day. The sutures were taken out at the end of a week. The wound healed by primary intention but afterward in the lower corner the fat skin pulled apart but there was no purulent secretion. The scar broke down and a suppuration began which kept the patient from going home for 2 months.

During the first 2 to 3 weeks after the operation the patient had severe pains in the abdomen. These pains, coming on periodically, more often during meals and defæcation, were of a blunt dragging character. The cause of the pain was probably the peristaltic movements of the recently sutured intestine with the resultant extra strain on the mesentery. This was confirmed by the fact that the pains came on unexpectedly and every attack lasted 20 to 40 seconds.

I twice heard about the patient from doctors who saw her within a year and a half after the operation. She had a good vagina but sometimes a great flow of mucus.

Case 6. E. E., 24 years old, was examined in Moscow by gynecologists Professor Snegirev and Professor Cherniahovsky who found a congenital aplasia of the vagina and uterus; and Professor Cherniahovsky sent her to me to be operated upon.

Spinal anæsthesia was induced with 2 cubic centimeters of a 5 per cent solution of tropocaine plus alcohol 96 per cent 25 cubic centimeters, but this did not maintain anæsthesia and the operation had to be finished under ether. The anatomical picture was the same as that found in the other cases. The opening between the bladder and rectum was easily and quickly made. The lower part of the jejunum had a broad enough mesentery. The piece of jejunum removed was 20.25 centimeters long. It was sutured end-to-end to form a ring. The ileocæcostomy was made end-to-side.

The postoperative period was complicated by a bilateral Erb's paralysis. On the left side the paralysis lasted 5 or6 days; on the right, the paralysis of the sixth cervical (axillary) nerve lasted 3 weeks, being relieved only after massage, gymnastics with weight over a block, and energetic galvanofaradization. The abdominal wound healed by primary intention. The intestine grew in well and was opened with a Paquelin cautery 3 days after operation.

Excoriation at the introitus made change of drains very painful, the drains entering readily and painlessly except through the inflamed introitus. In 3 days all pain ceased and in a month the patient went home, taking with her three thick Hegar dilators. In 2 weeks she came back saying that all was not well. Coitus was usually easy, but at times it was not possible, I found everything in good condition except that in this case the spur was much nearer to the exterior than in the other cases, and the partition was more compact and massive. But on each side were quite free passages, and I thought that the spur could not be an irresistible impediment to coitus. This problem was solved during a douche as such energetic peristalsis began that the nozzle became tightly squeezed in by the intestine. At the same time the neighboring passage was closely shut so that a finger could not pass through it. Since both passages were composed of adjacent intestinal segments, they closed simultaneously when the wave of peristalsis reached them. Several times during the 6 days that the patient was in my hospital for treatment with bougies (rubber drains 2 centimeters in diameter being used), I noticed that the peristaltic

Fig. 1. Case 2.

waves lasted 1 or 2 minutes and simultaneously pains were felt similar to those experienced during the postoperative period, except that they were not so severe. The connection between these pains and the straining of the mesentery during a strong peristaltic wave was here clearly seen.

I decided that I would probably have to put an indwelling crushing forceps on the spur, but before doing this I wished to consult with Dr. Mandrika, who, as I knew by a report of the Moscow Surgical Society, had done this. He had demonstrated the case at a meeting 4 years after he had performed the Baldwin operation. In the meantime I asked my patient to return to her husband. When in 2 weeks we met at Dr. Mandrika's, my patient said she was content. In the 2 weeks she had not used the drains and yet coitus was easy. She complained only of the secretion of mucus which, however, was never abundant and came on periodically.

From a study of this material, two questions present themselves: (1) To just what extent does the Baldwin operation solve the problem at hand? (2) How great is the risk to life?

In all 6 cases a very good artificial vagina was made which fully satisfied both husband and wife. Some of my patients said that to a considerable degree they had libido and orgasm. Other complications were pains from peristalsis of the resected intestine and secretion of phlegm.

The pains were noted in two of my cases soon after the operation only and ceased very soon without treatment. As this pain is brought on by the straining of the mesentery during increased peristalsis of the intestine, its severity depends upon the width of the mesentery.

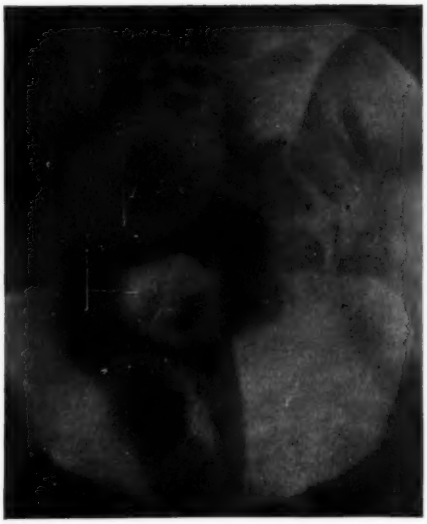

Fig. 2. Case 3. One month after operation.

We cannot think of a sure way to avoid these pains as it is difficult to do anything to make the mesentery longer without endangering the nourishment of the intestine. We may console ourselves by the fact that the pains soon pass away, probably as soon as the intestine and the mesentery adapt themselves to the new position.

The abundant secretion of mucus was noted in 4 of my cases. It did not cause irritation or eczema in any case. The secretion is very moderate and occurs always periodically, but still it stains the linen and must be counted as an argument against the operation. But I do not doubt that all of the 4 patients who complained of the mucus claimed a greater inconvenience than was really present. Before the operation not one of them had had menses and were therefore not acquainted with this inconvenience. Furthermore many women have leucorrhœa or menorrhagia and get accustomed to it and continue to live and work. In 3 of my cases I verified the amount of mucus and found it to be very moderate. The fourth had more, about 1 or 1.5 ounces a day. I suggested to her that we shorten the intestinal loop, but she refused to have the operation.

Fig. 3. Case 3; 2 years after operation.

Fig. 4. Case 4.

Taking into consideration all of these facts, I believe that too long a loop should not be taken. However, the disadvantage of the secretion of mucus does not outweigh the advantages of the Baldwin operation. Of course one cannot count on maintaining a strict diet, but Stoeckel observed that when his patient ate albugineous food, 6 cubic centimeters of mucus was excreted from the section of intestine, but when she ate fatty food, only 1 to 2 cubic centimeters was excreted.

In our series we had no deaths.

The question of danger from the Baldwin operation is brought up in the literature many times, most often by those who have used the Popov-Schubert method. Doederlein and Kroenig (1924) in the last edition of their book claim no personal experience, but cite Stending who gives a death rate of 22 per cent in a review of 49 cases in which the Baldwin operation was done. In this book is also given a review of 53 operations per rectum without death and 2 more operations by Schubert with death issues (Doederlein and Schroeder).

In the same year (1924) at the sixth reunion of Russian gynecologists and accoucheurs in Moscow, Dr. Rabinowitch reviewed 106 cases of the Baldwin operation with 15 deaths, a mortality of 14.1 per cent; and 61 operations by the Popov-Schubert method with 4 deaths (6.6 per cent). Rabinowitch (5) gives tables of all the cases with the places of publication of each case. The analysis shows that in 4 fatal cases the operation was complicated by other conditions. Therefore the death rate from the Baldwin operation can be reduced to 10.3 per cent; that is, the results are only a little worse than those reported from the use of the Popov-Schubert operation.

I do not care to criticize a method which I have not used and which I have never seen used by other surgeons, but I think that technically the operation on the rectum must be much more difficult because aseptic conditions in this region are not easy to maintain and neighboring organs can easily be seriously damaged (Doederlein and Schroeder's cases).

ADDITIONAL CASES

I have found a few cases which Rabinowitch does not mention. Professor Kakuschkin (3) of Saratov, in 5 operations by the Popov-Schubert method lost 2 from peritonitis, and mentions 1 case of death from peritonitis in the hands of Popov himself. Besides these 6 I know of 1 more case in which the patient after an operation by the Schubert method died within a year in another hospital from a deep phlegmon of the pelvic tissue and stercoral sepsis. This adds 7 cases with 4 deaths. And I wish to add several unpublished cases of the Baldwin operation reported to me by Moscow surgeons; Choline, 2; Krassinzew, 1; Malinovsky, 1; Atabekow, 1; Gudim-Levkowitch, 1; Schitow, 2; Kazansky, 1; Mandryka, 1; Chodkov, 1; Garmsen, 3; Alexandrow, 1; and my 6 cases. In these 21

Fig. 5. Case 6; 2 weeks after operation.

Fig. 6. Case 6; 6 months after operation.

cases there were 2 deaths from peritonitis. One operation could not be completed because of a narrow mesentery. In 1 case when the cautery was applied the rectum was wounded and a fæcal fistula resulted which closed spontaneously.

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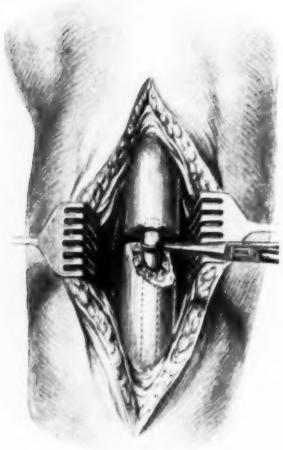


Fig. 4.

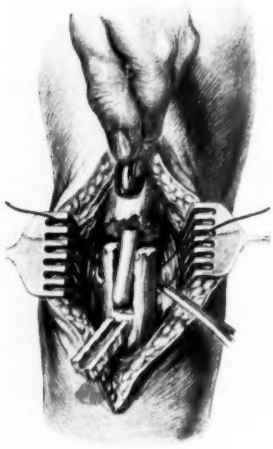


Fig. 5.

Fig. 6.

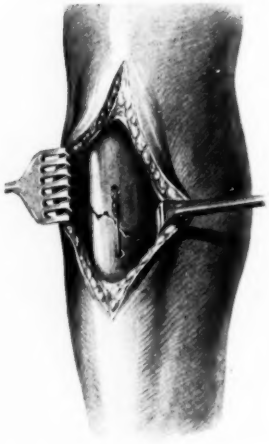


Fig. 7.

Fig. 4. The insertion of the peg with forceps.
Fig. 5. Osteoplasty and insertion of the peg.
Fig. 6. Bone suture with the aid of wire and drill holes.
Fig. 7. Complete bone suture.

Technique of Open Reduction of Fractures.—M. Kirschner.

CLINICAL SURGERY

FROM THE SURGICAL CLINIC, UNIVERSITY OF KOENIGSBERG

TECHNIQUE OF OPEN REDUCTION OF FRACTURES[1]

By PROF. DR. M. KIRSCHNER, KOENIGSBERG, GERMANY
Director of the Surgical Clinic

THE JUSTIFICATION FOR OPEN REDUCTION

IN the treatment of fractures the development of conservative methods such as Steinmann's nail extension, wire extension, and the adequate relaxation of the musculature advocated by Zuppinger, has reduced considerably the number of cases in which a closed reduction of fragments is unsuccessful. Even the most experienced surgeon will have to see fractures which in spite of skillfully employed conservative measures cannot be reduced satisfactorily. A healing in malposition means not only deformity but also usually an impairment of function associated with an often irreparable damage to the neighboring joints. Besides, with considerable dislocation of the fragments a bony union is not accomplished. Methods of open reduction then are unquestionably justified all the more as after long union in malposition, a spontaneous correction of the deformity can be expected only during the period of growth and even here only after a long lapse of time. It would mean an unworthy capitulation to our modern surgical asepsis if we were to look on inactively at a marked crippling from fracture.

If we still encounter in many instances a tendency to discount surgical interference, it must be because of the dangers and secondly because of the failures of osteorrhaphy. The dangers of osteor.haphy are first of all those of any surgical interference. In most cases, suturing of bone ought to be carried out under general anæsthesia to obtain a complete muscular relaxation; but no general anæsthesia is without danger.

The second danger is that of infection. The conditions favoring this possibility are the badly damaged, torn, and crushed tissues, the multilocular wound pockets that are kept patent by bone spicules, hæmatomata, and bloody imbibition of the vicinity. The chances for an undisturbed healing like that occurring in clear-cut incisions are very poor. Also the extensive movements during reposition, the unavoidable crushing of tissues, and the foreign material introduced for the suture, favor infection.

I cannot substantiate, however, another generally made objection that bone-suture increases the chances for fat embolism. This has not been the case in my experience.

FAILURES OF OPEN REDUCTION AND BONE SUTURE

The results of the operation are not always proportionate with the dangers and discomfort suffered by the patient. Bad results may be due first of all to the inadequacy of anatomical reconstruction either because the reduction of fragments was primarily unsatisfactory at the operation, or because in spite of adequate reduction, a secondary dislocation of the fragments occurred before consolidation. However, in many cases of successful anatomical reconstruction the functional result is bad because of stiff joints, motor disturbances of tendons and muscles, atrophy of the musculature, and circulatory disturbances. Such functionally unsuccessful cases are usually the consequence of an all too long and extensive immobilization which has been instituted for fear of a secondary dislocation of the reduced and fixed fragments.

The final reason for failure is the inadequate technique of the usual bone suture. The efforts for improving the technique have been carried out, as outlined above, in two directions: (1) complete anatomical reconstruction; and (2) the holding of the fragments firmly together that even in spite of movements no dislocation of the fragments can occur.

The description of my technique for bone suture which follows shows how both requirements are usually fulfilled. I am dealing here only with recent fractures of the long bones and will not discuss the treatment of splintering in the neigh-

[1] Translated by G. de Takats, M.D.

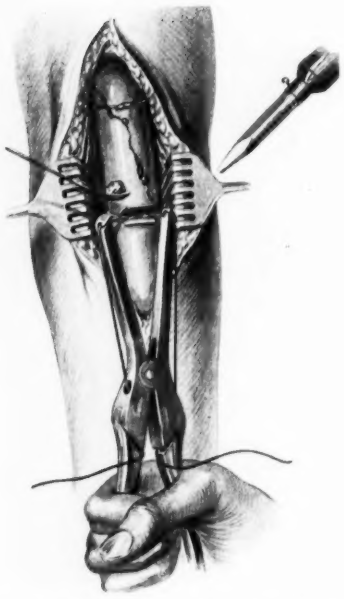


Fig. 1. Circular bone suture by means of traction forceps and the application of solder.

borhood of joints, of old fractures, of fractures with impeded or no consolidation; or of the bridging of bony defects.

TIME OF OPERATION

In case of closed reduction of fractures, the reposition must take place immediately; every hour increases the difficulties of reduction. The surgical treatment of recent fractures, however, requires different consideration. Generally I prefer to operate only after 8 days, when the reparative reaction of the tissues is in full progress and when the tendency to infection is evidently lessened. An immediate operation is performed only when a protruding fragment endangers the nutrition of the skin, when a complicated, open fracture is present, or when the bone suture is combined with an immediate débridement and revision of the wound.

TECHNIQUE

Pre-operative preparation. The 8 days of waiting must not be spent inactively. If the indication for open reduction is not definite, conservative methods of treatment should be tried. If the operation has been decided upon, an immobilization in possibly reduced position is instituted. Damaged skin is treated with zinc paste. Considerable elevation of the limb in order to reduce the œdema and hæmatomata as much as possible is important. A broken arm is splinted and suspended at an angle of 130 degrees at the elbow. The lower extremity is splinted in such a manner that the thigh lies nearly vertically and the calves make an angle of 45 degrees with the horizontal plane.

The usual pre-operative preparation for operations on extremities is applied. The bath the day before the operation is omitted so as not to mobilize the fragments again. In case of extensive contamination, the skin is cleansed with benzine after the patient is under the anæsthetic.

I draw the line of incision on the skin with my unwashable dye so that unnecessary palpations after the aseptic preparation are omitted and correct position of the incision is assured. If the site of fracture cannot be well located from the outside, an X-ray picture is taken with a metal mark on the skin. The line of fracture and its relation to the surface can thus be determined in millimeters. Form and position of fragments are best determined by stereoscopic films, which I consider indispensable. They are preferred to the usual X-ray pictures taken in two planes.

The skin is disinfected by painting it once with a tincture of tannin (acidi tannici 7.5 grams, spiritus vini ad 100.00, and a few grains of fuchsin). I have used this tincture for more than 10 years in many thousand operations of all kinds, and prefer it to the tincture of iodine. Aseptic towels are glued to the skin close to the line of incision with mastisol[1] and fixed with towel clips or sutured to the skin.

To secure hæmostasis, an Esmarch's bandage is used in fractures of the lower extremity but never in those of the humerus, because of the danger of injury to the nerves. If the fracture is situated on the distal part of the lower arm, a sterile constricting band may be applied immediately under the elbow. A very careful control of the bleeding is necessary to avoid hæmatomata, which again may favor infection.

Steps of open reduction operation. The fracture is exposed usually through a longitudinal incision on the side, where the bone is the nearest to the skin, and where no important structures can be injured. Occasionally it may seem advisable to expose the bone with two incisions lying opposite each other. If the bone is covered with muscle, an interstitial space is chosen for the approach, which however should not contain large vessels or

[1] Mastisol is the solution of gum mastic in benzol with a few drops of olive oil.—Translator.

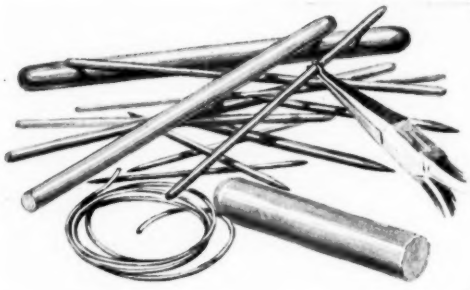


Fig. 2. Ivory pegs, metal pegs, and wire for fixation.

Fig. 3. Insertion of the peg with the fractured bone in flexion.

nerves. If vessels and nerves cannot be avoided, they must be well exposed and protected with retractors. The incisions should be large enough to permit an adequate approach and exposure of the fragments. Large incisions permit a more gentle and careful handling of tissues and are therefore ultimately more sparing than small incisions. Flap incisions are used only exceptionally. If both bones are broken on the lower arm, each bone is exposed with a separate incision. In recent fractures of the leg, the position of the fibula may be neglected so that the exposure of the tibia only is necessary.

The periosteum is of greatest importance for the life and regeneration of bone, and for the formation of a callus. The bone marrow is of minor importance. The periosteum receives its nutrition mostly from the surrounding muscles and should then remain in contact with them which means that the fragments must be freed subperiosteally. A longitudinal incision is made in the periosteum, but if necessary transverse incisions may be added. With the help of adequately curved periosteal elevators, the periosteum is pushed off with utmost care. If the right line of cleavage is once found, the rest of the separation will be easily carried out. The fragments must be exposed to such an extent that they can be completely visualized. During the further steps of the operation, the periosteum and soft parts are protected and retracted with retractors and elevators.

The further steps in the operation are the reposition of the fragments (osteosynthesis), and the fixation of the fragments to each other (bone-suture).

In order to bring the broken surfaces into proper position, axial traction, angulation, lateral pressure, and twisting movements are applied with the help of sharp and blunt bone retractors, various elevators, bone forceps, etc. The adaptation of the fragments succeeds often if the fragments are first dislocated into the wound, opposed against each other at a sharp angle, and then finally pressed against each other so that the angle disappears. If a good adaptation of the fractured surfaces is not obtained in this manner, then bone must be sacrificed. First the outstanding edges are clipped off and then one or both of the fragments are shortened, but with the greatest parsimony. If a more extensive shortening is unavoidable, it is performed in a stairway-form as a preparation for the suture. This is very rarely necessary in recent fractures and has particular drawbacks in the upper extremity.

Bone suture. Fixation of the fragments after the reduction is not necessary in every case. However, the permanency of the good position of the reduced fragments is so important that special fixation will be omitted only when the fractured ends firmly hook into each other. In almost every case, if one has already exposed the fragments, he will be inclined to institute a solid mechanical connection between the fragments; in other words, a bone suture. The operative surgical procedure, if once undertaken, should be complete.

In regard to bone suture, two types of fractures must be distinguished: the oblique and the transverse. A third type of comminuted fracture, with several loose fragments, requires open reduction very seldom, because the fragments are easily mobilized, and conservative measures, especially wire and nail extension, suffice as a rule. The only exception to this rule is the comminuted fracture of both bones of the arm. Such exceptions, however, are readily classified into one of the two above groups.

The anatomical distinction between oblique and transverse fractures is not sharp. So far as the technique of the bone suture is concerned, the two types are distinguished in the following

manner: Oblique fractures are those that can be firmly united with a circular wire. The stairway reconstruction mentioned above makes an oblique fracture out of any type. Transverse fractures are those which cannot be held firmly together with a circular ring; questionable cases belong in this group.

The fixation of oblique fractures. The fragments are united after the reduction with one, or, if possible, two rings of wire, applied very firmly (cerclage). The usual wire cerclage is, however, insufficient. The traction of the wire by hand, and the twisting with a wire forceps can never obtain primarily a firm connection. The apposition is so unsafe that any secondary force will dislocate it. Innumerable X-ray plates made by our best surgeons testify to the accuracy of this statement. On the other hand, I obtain, with the help of a special wire forceps, the greatest possible tension, and by the soldering of the two ends of the wire, an absolutely reliable union.

Because of the great amount of tension exerted on the wire, it must be strong, especially if we want to avoid the use of too coarse wire. Coarse wire is not desirable in view of the increased amount of foreign body left in the tissues. Furthermore, the wire must be soldered to form the ring mentioned above. Both conditions are fulfilled by the piano steel wire. This material, however, must be heated up to red heat on a coal fire by a special process to make it pliable. This procedure does not lessen the strength of the wire. Other material, such as aluminum-bronze, silver, rustless steel, or twisted Viennese wire, are useless for our purposes. They are either not resistant enough or they cannot be soldered. The piano steel wire is used in calibers of 0.5, 0.7, and 1 millimeter.

After the wire has been inserted around the fragments, the ends are tied once in the form of an ordinary knot. The two ends of the wire are inserted into the slits and openings of the wire forceps. The wire is pulled taut, and meanwhile the branches of the forceps are approximated. By pressing together the branches of the forceps, the ends of the wire are tightly caught and the ring around the fragments can be given the desired tension. Not only does the wire now encircle the fragments as a tight ring, but it also presses the fragments against each other in such a way that a maximal grade of adaptation is obtained.

The closure of the ring is obtained in the following manner. Before tension is placed on the wire, a quadrangular piece of sterilized fiber about 1/10 millimeter thick is laid under the first knot. Its two ends are curved upward. As the tension is exerted by the wire forceps, the thin pad of fiber is snugly fixed. The pad is now surrounded by wet compresses, which must be wrung out well. The point to be soldered is brought into a position as nearly horizontal as possible, and a small amount of tinol[1] applied to the wire. The solder has been previously sterilized in a water-bath in the original can. A soiling of the tissues around the gauze pad is carefully avoided. An electric soldering iron is now applied to the point to be soldered, during which the ring is put under maximal tension. The soldering iron should come in contact only with the soldering material and the wire. As soon as the solder melts, it is distributed over the whole area of the crossed wire, and leaves a considerable lump of metal to harden over the wire knot. Cooling of the solder may be accelerated by the application of cold saline compresses. Only after the mass is hard is the tension on the wire slowly relaxed. If the wire knot is not soldered satisfactorily, the soldering must be repeated with another application of tinol. The ends of the wire are now clipped very short. Any excess of soldering material is removed with wet pledgets of cotton. The pad is now removed by cutting it across along the wire, or simply by tearing it out from under the knot. The whole area is now once more sponged with wet sponges in case some welding material has gotten into the tissues. The bony union obtained by this procedure is of maximal solidity.

Occasionally the solid closure of the ring by soldering is unnecessary. In such exceptional cases, the closure of the ring may be obtained by twisting the wire. Under uniform tension, the wire forceps are twisted several times in the same direction, so that the ends of the wire twist around each other symmetrically. The rigidity of the piano wire prohibits the loosening of this type of closure, so that a comparatively reliable and firm closure is the result.

If the form of the oblique fracture permits, I always try to use two parallel rings at the greatest possible distance from each other. The firmness of the union is greatly enhanced by this double ring. In order to prevent the slipping of the ring from the end of the fragments, it may be helpful to file out a bit of cortex as a groove for the wire.

The fixation of transverse fractures. The fragments of the transverse fracture are united by a bone-marrow peg. This peg is always made out of ivory. Autoplastic bone pegs are used only in cases of pseudarthrosis or of bony defects which have to be bridged over; but this is not in the scope of our present discussion. The ivory is

[1] *Tinol* is a German brand of soldering material.—Translator.

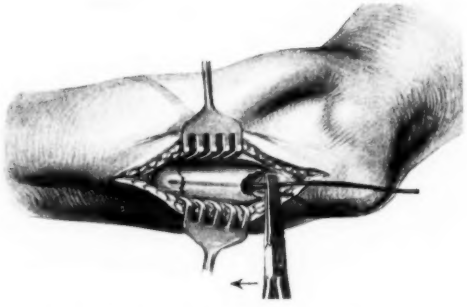


Fig. 8. Application of wire at a distance from the fracture.

absorbed in a few months and substituted by living bone so that it does not act permanently as a foreign body. I keep a number of round ivory pegs of assorted sizes with 0.1 millimeter difference in diameter. The deeper the peg is inserted in the bone marrow and the more firmly it is fixed, the better the union will be. Yet the length of the peg must be limited, as after the introduction into one fragment, the introduction into the second fragment is confronted with certain difficulties. These difficulties may be overcome by the following three procedures:

1. If necessary, an ivory peg is selected that can just be pushed into the wider marrow-cavity, which is usually the proximal one. It is inserted into this end for a trial as far as it is supposed to go, and the depth of its position is marked with a blue dye. Next the peg is hammered into the narrower canal of the other fragment firmly. Its outstanding end is shortened with the saw so as to enable a sliding in of this end with the help of adequate movements. The length of the remaining portion of the peg should by no means exceed the previously measured length of the peg in the wider canal. The sawed part of the peg should be rounded off with raspatorium and file. At the site of fracture, through introduction of the tip of the peg into the second canal and renewed traction, it is attempted to snap in the peg. If this is unsuccessful, then the peg is shortened step by step, each time after reduction is attempted. A certain length for the safety of the bony union is indispensable, and this length should not be sacrificed. If the shortening of the peg has reached this limit, and the introduction of the peg is still impossible, other methods must be tried. There are two possibilities.

2. The peg which has been hammered into the narrower fragment is removed and a smaller size taken. It is first ascertained that this peg can be pushed in and out of the narrower canal without any difficulty. Then the peg is made the necessary length and the point on the peg is marked which is to lie just at the site of the fracture. Next the peg is inserted into the wider canal so deep that just the tip of it enters into the canal of the narrower fragment. A special narrow bone forceps applied between the two fragments now pushes the peg more and more into the narrower canal so long as the mark appears. In case the forceps cannot be inserted between the two fragments, enough bone may be clipped from one fragment to allow the application of the bone forceps.

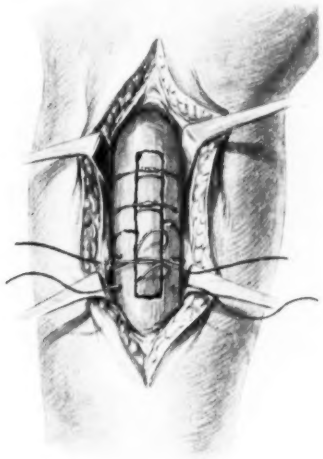


Fig. 9. Insertion of the peg and fixation with wire suture.

3. If the peg cannot be inserted in the way described, then as a last resort the marrow canal of one fragment can be opened by chiseling off a bony plate corresponding to the length of the peg to be inserted. In this way it is possible to push in the peg from the side after it has been hammered into the other end. The bone flap should possibily remain in contact with the bone by preserving its periosteal attachment. It is laid back again over the peg and fixed with one or two circular wires as described above.

Further methods seldom applied. The two methods described, the cerclage and the peg, suffice for most of the cases; exceptionally, however, it becomes necessary to resort to other methods of bone suture, such as wiring through drilled holes, pegging at a distance, or inserting a lateral splint.

It may be useful now and then to pull the wire through drilled holes. The closer the holes are

made to the fractured surface, the firmer is the connection between the fragments. The wire is put under tension with the tension-forceps and soldered, as already described. As the drilling of the bone and the insertion of the wire retards the rejuvenation of bone, I use this method rarely.

A particular kind of peg is used occasionally on the ulna. The marrow is opened far away from the fracture, the two fragments are placed in the right axis and a strong silver wire of measured length is pushed forward from the new opening in the bone until a sufficient amount of the wire has entered the other fragment.

A combination of cerclage and pegging is a connection obtained by the insertion of a lateral splint. After an exact adaptation of the fragments has been made, incisions several centimeters long are made in both fragments with the help of a double circular saw. This saw contains two steel-plates at a distance of ½ to 1 centimeter from each other. The strip of bone that this saw outlines is now chiseled into a quadrangular groove. Two wires are now inserted in a transverse direction through both fragments after holes have been drilled for this purpose. Each wire is visible on the bottom of the bony groove, and both wires are pulled forth and form a loop above the groove. A quadrangular piece of ivory that fits exactly into the groove is slipped in under the wires and pressed into the groove. The wires are now put under tension with the wire forceps and soldered. The method is too complicated, and is used only in case of necessity.

With one of the above described methods, a solution will always be possible. Other methods which I consider unreliable, such as lateral application of metal plates or the introduction of metal clips, are not used.

The reconstruction of the wound. After the bony union is completed, careful hæmostasis is effected. The wound is closed in layers, the muscles, fascia, and skin being sutured separately. The wound is not drained except when we are dealing with an open, badly infected fracture. The wound is covered with an aseptic dressing which is removed with the stitches, that is, not earlier than a week after operation.

AFTER TREATMENT

The above described bony union is very firm, usually just as firm as the uninjured bone. Therefore a complete or long immobilization of the injured part is not necessary. After the healing of the soft parts, that is approximately after the first week, certain active and passive motions are permitted. Thus even in cases of open reduction the advantages of functional treatment of fractures may be enjoyed.

Usually no circular cast is applied, but only a splint of plaster-of-Paris or wire is used. In either case a steep elevation of the part is instituted in order to decrease the swelling and prevent hæmatomata, or facilitate their absorption.

A few days after the operation, with the bandage still in place, the patient is urged to send small voluntary impulses to the injured part. After 7 to 10 days, when the bandage is removed, if the wound has healed by primary intention, I begin to apply heat in the form of electric pads and electric lamps. Massage with light active and passive motion is instituted, overtaxing of the suture being avoided. The best index of the right amount of stress is the impulse of the patient, the desire to move around which increases from day to day. In some overanxious patients this has to be encouraged. Step by step more requirements are met by the fractured part, until finally after the use of Thomas splints, sports may be taken up.

If an infection sets in, the wound must be partially or completely opened. A phlegmon is treated with the usual methods of incision and drainage. The bone suture is not touched as the immobilization obtained by the suture is an excellent weapon against the spreading of infection and finally will enable the fragments to heal in the best position. If a sinus persists, the wires and perhaps sequestra must be removed after consolidation. I was never compelled, however, to remove the ivory peg from the bone marrow. Occasionally several years after an aseptic healing of the wound, signs of irritation are produced by the wire. They can be easily removed under local anæsthesia. The ivory pegs are absorbed in a few months and do not cause late suppuration.

Advantages of the firm union. The absolute reliability of the type of bone suture described permits of early functional treatment. On the basis of extensive observations I have gained the impression that not only are the impending consequences of a fracture, such as muscular atrophy, stiffness of joints, and circulatory disturbances reduced to a minimum, but the time of consolidation is materially shortened; and that constant use of the injured extremity causes the development of callus which is correct in form and structure; whereas long immobilization will frequently cause hypertrophic and purposeless callus which again will result in long lasting circulatory and functional disturbances.

NOTE.—The illustrations are taken from the textbook of surgery by Kirschner and Schubert which is in press with Julius Springer, Berlin and Vienna.

FROM THE ORTHOPEDIC DEPARTMENT, CHILDREN'S HOSPITAL, BOSTON

OBSTETRICAL PARALYSIS

By JAMES WARREN SEVER, M.D., F.A.C.S., Boston
Associate Surgeon, Children's Hospital

THE usual deformities present in obstetrical paralysis are contraction of the adductors and internal rotators of the humerus, and posterior subluxation of the shoulder joint, with hooking down of the acromion in the older cases. This acromial deformity, however, does not occur except when there is a posterior subluxation of moderate degree, sufficient at least to remove the head of the humerus from its normal position enough so that it no longer acts as a buffer to the acromion. This deformity never occurs in young children, but is seen only in the older patients, that is, in the cases of at least a year's duration, and generally not markedly then.

The reason the adductors and internal rotators are contracted is that their opponents are paralyzed temporarily, and when they partially recover spontaneously are not then strong enough to overcome the contractions. Certain cases show late, that is after several years, a partial dislocation of the head of the radius due to the paralysis of the supinators and the recovery of the biceps.

These children cannot abduct the arm well, cannot elevate as a rule to beyond the shoulder level, cannot supinate more than one-half normal, and outward rotation of the humerus is much limited.

AUTHOR'S OPERATION FOR OBSTETRICAL PARALYSIS

An incision is made on the anterior aspect of the arm, beginning at the tip of the acromion and carried down to below the insertion of the pectoralis major. The cephalic vein is found generally in the outer edge of the wound and is tied or retracted outward. The tendinous insertion of the pectoralis major is defined, raised on an instrument, and divided all the way across.

Fig. 1. Skin incision and isolation of pectoralis major. Cephalic vein at outer edge of pectoral. Arm abducted and rotated out. Insert shows position of arm and line of incision.

Fig. 2. Sound under subscapular tendon. The pectoralis major has been divided. The joint capsule shows at bottom of cavity. At operation the three horizontal circumflex veins can also be seen in the bottom of the wound.

Fig. 3. Obstetrical paralysis right arm, upper arm type, showing inability to abduct, outwardly rotate, and supinate.

Fig. 4. Note ability to put hand to the head easily 1 year after operation.

Fig. 5. Free abduction, outward rotation, and supination 1 year after operation. Same case as that shown in Figures 3 and 4.

The pectoralis major muscle is retracted inward, out of the way, thus bringing into view at the bottom of the wound the inner edge of the coracobrachialis muscle. This muscle is defined upward until the coracoid process is reached, the arm being outwardly rotated and abducted. The tip of the coracoid process, which is usually found elongated, is completely separated from its base, together with the insertion of the coracobrachialis, the short head of the biceps and the pectoralis minor. Not more than about one-fourth or three-eighths of the tip needs to be removed to accomplish this. This allows the coracobrachialis and the short head of the biceps to retract downward out of the way, and allows much freer outward rotation and abduction of the arm. The capsule of the shoulder joint is seen in the bottom of the wound as well as the three horizontal circumflex veins. Just above the upper vein is the lower edge of the subscapularis tendon. This lower edge should be defined. A curved instrument is inserted just underneath this tendon, which is fairly

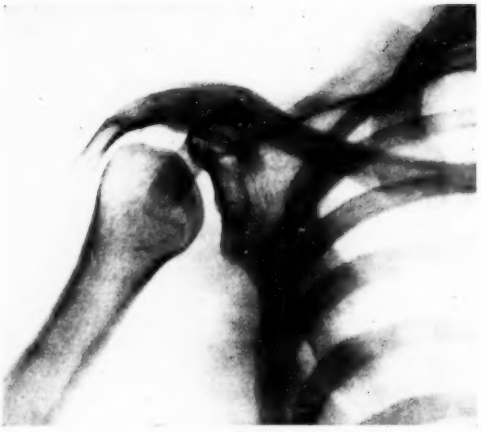


Fig. 6. X-ray shows bony deformity of the shoulder joint in a case of obstetrical paralysis of the upper arm type, marked hooking or elongation of the acromion, marked elongation of the coracoid process, and posterior subluxation of the head of the humerus. At operation both these bony obstructions had to be removed before the subluxation could be reduced.

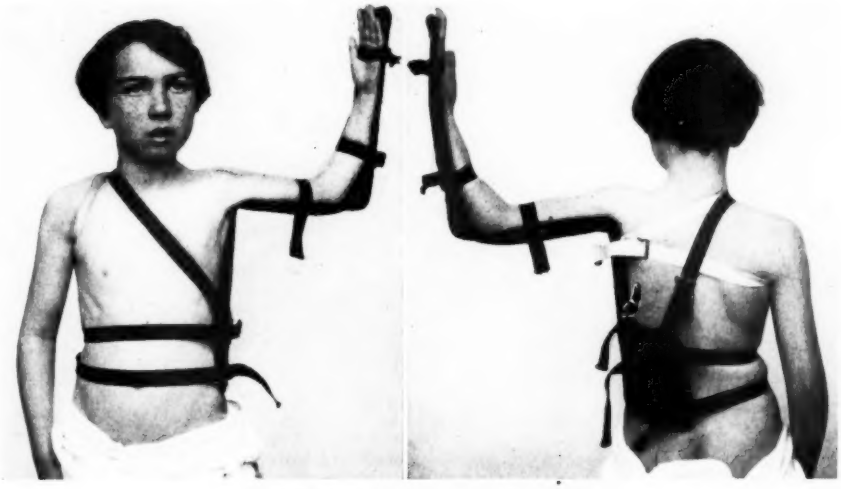
wide at this point, and the tendon is completely divided on the instrument. This prevents any opening of the shoulder joint capsule; and, once this subscapularis tendon has been divided, outward rotation, abduction, and elevation of the arm are perfectly free.

The only condition then that will block free outward rotation, abduction, and elevation is a considerable degree of hooking of the acromion. If this condition exists, such portions of the acromion as block the restoration of the head of the humerus to the glenoid should be removed. The operation is then complete and the only stitches needed to close the wound are stitches to the fascia and skin. The arm is put up on a splint in an abducted, elevated, outwardly rotated and supinated position.

In a certain number of patients in whom the pronator radii teres has become very much contracted, we have divided this muscle with great benefit to increase supination.

Muscle re-education, active and passive use of the arm, begins just as soon as the stitches are out, which is in about 8 or 10 days, and is continued daily for 3 months with the arm in a splint.

There are one or two postoperative conditions that have bothered us a good deal: (1) For about a year after this operation, and sometimes even longer, there is considerable difficulty in passively



Figs. 7 and 8. Splint used after operation.

inwardly rotating the upper arm, or in putting the hand on the opposite shoulder. (2) In almost all cases after operation there is a good deal of limitation of rotation in the joint itself, which, however, is eventually overcome. (3) With the arm hanging at the side, there persists almost always a considerable rotation of the scapula in a vertical plane, even when there is apparently free motion of the shoulder joint. Just why this is we have not been able to determine. It does not impair the function of the arm, but does not make for a cosmetic success.

A NEW METHOD OF CORRECTING COMPLETE INVERSION OF THE VAGINA

With or Without Complete Prolapse; Report of Two Cases[1]

By NORMAN F. MILLER, B.S., M.D., Ann Arbor, Michigan
Assistant Professor of Obstetrics and Gynecology, University of Michigan

RAPID strides have been made in gynoplastic surgery in recent years and many material improvements have been established in the treatment of conditions requiring plastic repair. The work of Rawls, Watkins, Bissell, Noble, Broun, and others has resulted in excellent methods for treating various pelvic lesions, particularly cystocele, rectocele, and descensus. Improved methods of dealing with these lesions have largely done away with recurrences. A possible exception to this advancement in gynoplastic procedure, however, is in the treatment of complete inversion of the vagina occurring alone as after pan-hysterectomy or in conjunction with complete procidentia. Operations for correcting these lesions are still quite complex and without compensatory end-results.

Complete obliteration of the vagina has been the result in many instances and indeed colpocleisis has frequently been the distinct aim of the operator. While the gynecologist is not often called upon to treat complete inversion of the vagina, results in cases treated have not always been satisfactory. It was this feeling of dissatisfaction with the results commonly obtained as well as the relatively large number of these cases seen in this Clinic that stimulated the writer to devise, if possible, a more satisfactory method of treating this type of lesion. An entirely new method of correcting this condition is the result of this research. While the operation has been performed in only 2 cases, 1 for complete inversion following pan-hysterectomy (Fig. 1) and the other for complete prolapse of the uterus with complete inversion of the vagina (Fig. 2), the technique is herewith presented in the hope that others may try the procedure so that defects may be discovered and its true value proven.

The first patient operated upon by this method, Mrs. M., Case 19223, was a thin woman of 59. She was admitted to the Clinic on January 20, 1925. She complained of complete loss of support and a dropping of the bladder, vagina, and rectum. The patient suffered considerably from the protruding mass on walking and from the more usual bladder symptoms. It was impossible for her to empty the bladder completely or to obtain a normal bowel evacuation without pushing the mass back into the pelvis. She gave a history of having had a panhysterectomy with a bilateral salpingo-oophorectomy 4 years previously. One year following the operation when pulling weeds in her garden, the patient noticed that something gave way and the bladder, vagina, and bowel came down. For nearly 3 years following this accident the patient had used one pessary or another, but had finally reached the stage when a pessary could no longer be used, due presumably to irritation.

Examination revealed an incomplete laceration of the pelvic floor with complete inversion of the vagina (Fig. 1) There was an enormous cystocele and rectocele. The uterus and its appendages were absent. The entire mass protruded 4 inches beyond the vulva. There was a small mass of scar tissue at the apex of the vagina.

Laboratory findings were essentially negative. Urinalysis revealed a trace of albumin with many epithelial cells and a few pus cells on microscopic examination.

On January 27, 1925, the patient was operated upon and the lesion corrected by the method to be described.

TECHNIQUE OF OPERATION

The apex of the inverted vagina is grasped by a forceps and pulled down. A transverse incision about two inches in length is then made below the bladder reflexion (Fig. 3). This incision involves both the mucosa and the underlying pubovesicocervical fascia. A vertical incision is then made from the center of the above mentioned transverse incision up to within one-half inch from the external urinary meatus (Fig. 3). This incision is made by introducing a pair of scissors between the fascia and bladder and spreading the blades, then incising upward in the midline up to the point mentioned (Figs. 3 and 4). This incision also includes the mucosa and underlying pubovesicocervical fascia.

The line of separation between the bladder and overlying pubovesicocervical fascia is very distinct and no difficulty is encountered once the proper line of cleavage is found. The combined mucosal-fascial flaps are then dissected laterally off the bladder (Fig. 4), care being taken to carry this dissection to the lateral walls of the vagina. Next the fascia is dissected free as a distinct layer or flap from the combined mucosal and fascial flap on the right side only (Fig. 4). Here again the lines of separation are very distinct and no difficulty is encountered in separating the very strong and distinct fascial layer from the mucosa once a proper start is made. Generally,

[1] From the Department of Obstetrics and Gynecology, University Hospital, Ann Arbor, Michigan.

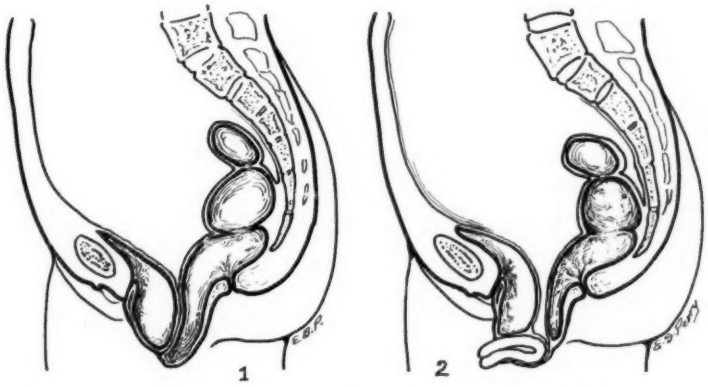


Fig. 1. Incomplete laceration of pelvic floor with cystocele and rectocele.
Fig. 2. Complete prolapse of the uterus with complete inversion of the vagina.

this is better accomplished by blunt rather than sharp dissection. The procedure thus far is largely that utilized by Rawls, Bissell, and others in their operation for cystocele. The scar tissue is then excised from the apex of the vagina and the peritoneal cavity opened at the same time. The dissection of the mucosal and fascial flaps laterally and the opening of the peritoneal cavity permits ready access to the intrapelvic structures. A No. 2 chromic catgut suture on a small full curved needle is passed through the peritoneum and underlying fascial and muscular structures at the base of the sacro-uterine ligament, approximately 1½ inches below the promontory of the sacrum on the right side (Figs. 5 and 6). The same procedure is then carried out on the left side. A goodly amount of fascial tissue is included in passing each of these lifting sutures (Figs. 5, 6, and 7). The index finger of the left hand serves as a very satisfactory guide to the needle in placing the sutures. After placing these two lifting sutures, the free ends are left hanging down through the peritoneal opening until the fascia overlapping of the anterior vaginal wall is completed (Figs. 8 and 9). The free layer of fascia on the right side is carried over the bladder and fixed along its free edge to the under surface of the combined fascial and mucosal flap of the left side at its base. Interrupted mattress sutures of No. 1 chromic catgut are used for this purpose (Fig. 8). The remaining mucosal flap of the right side is then removed and the combined fascial and mucosal flap of the left side carried over and fixed by interrupted chromic No. 1 sutures to the cut edge (Figs. 8 and 9). Following this the free ends of the lifting sutures are passed through the lower, free, transverse edge of the overlapped flap at least 2 inches apart (Fig. 10). The peritoneal cavity is then closed, and the remaining mucosal edges approximated (Fig. 10). The lifting sutures are next tied separately in the course of which the entire inverted vagina is carried high up into the pelvis and back toward the fixed point of the lifting sutures (Figs. 11, 12, and 13). This completely corrects the inversion of the vagina as well as the cystocele (Figs. 11, 12 and 13).

The rectocele and laceration of the perineum are next repaired by grasping the perineum at the region of the last caruncle on either side and excising the intervening edge. The posterior vaginal flap is dissected free up to the apex of the rectocele. Then starting on the vaginal surface at the apex of the rectocele, a No. 0 chromic suture is passed from without in, through the mucosa of the free post-vaginal flap and the fascial layer overlying the rectum pleated as shown in Fig. 14. The pleating is carried down to the base of the rectocele and reversing, brought up to the apex again, through the mucosal flap and tied to the other free end, as is commonly done for large rectocele. The perineorrhaphy is completed by removing the excess mucosa and bringing the levator-ani muscles together in the usual fashion.

The first patient made an uneventful recovery and at the time of discharge from the hospital presented a very satisfactory result. The direction, length, and support of the vaginal tract were very good. There was no tendency toward relaxation of either anterior or posterior vaginal wall. There was no tenderness. The vagina

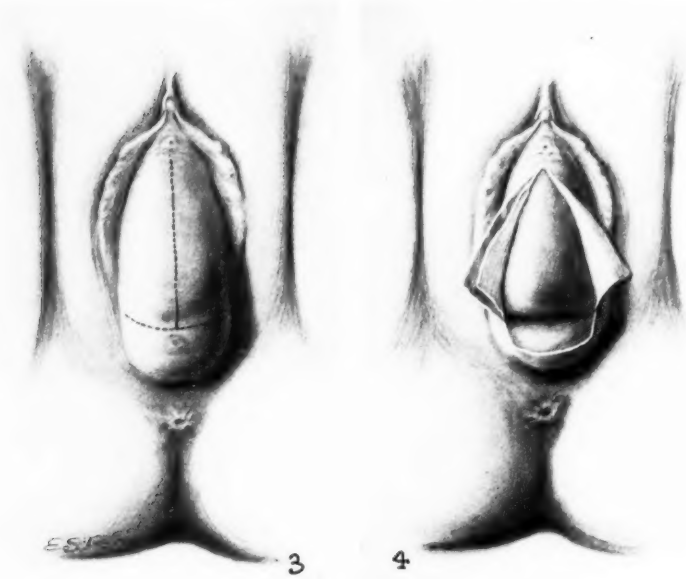
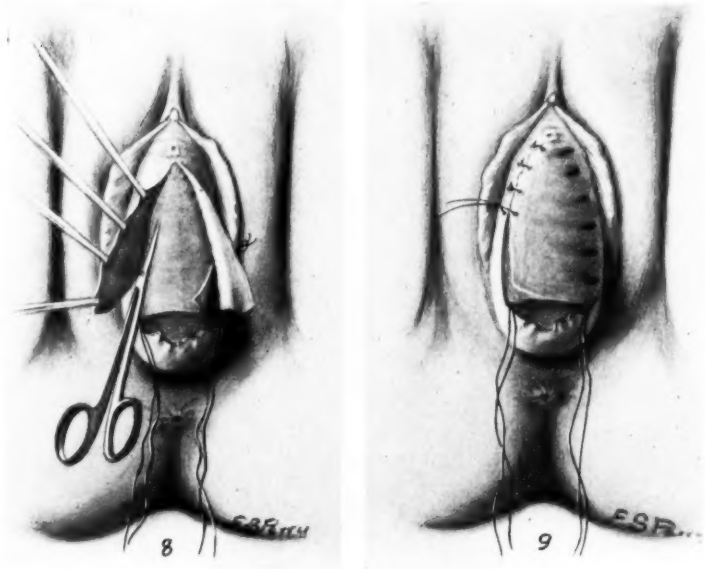


Fig. 3. Lines of incision.
Fig. 4. Incision completed and flaps dissected.

Figs. 5, 6, and 7. Method of applying lifting sutures.



Figs. 8 and 9. Method of fixing flaps.

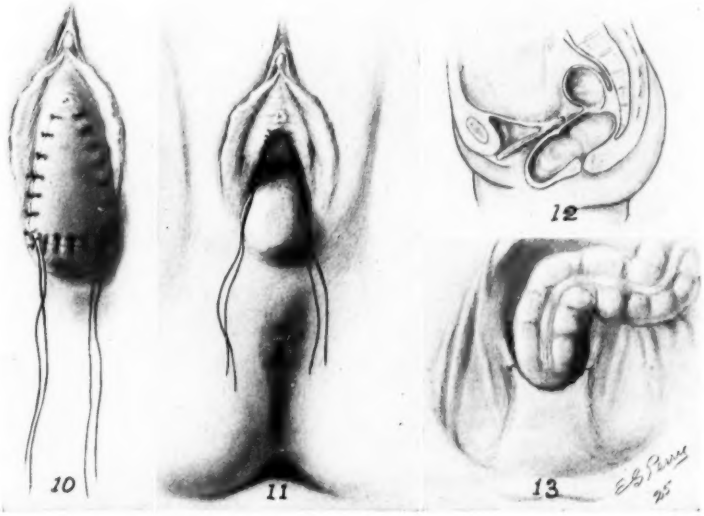


Fig. 10. The peritoneal cavity is closed.
Figs. 11, 12, and 13. The lifting sutures are tied so that the inverted vagina is carried high into the pelvis.

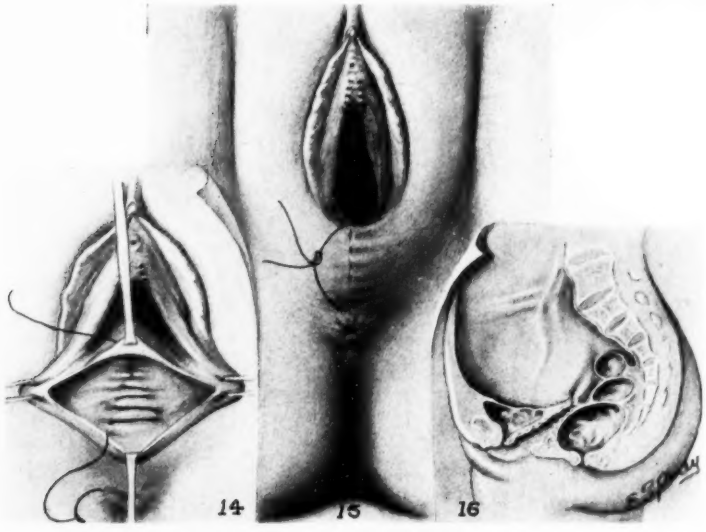


Fig. 14. The fascial layer overlying the rectum is pleated.
Fig. 15. Final steps in perineorrhaphy.
Fig. 16. Sagittal section showing position of viscera after operation.

admitted with ease the full length of both the index and middle fingers. There were no untoward symptoms of any kind. Rectal examination showed no evidence of pressure or stricture of this structure. There was no tendency toward narrowing of the bowel lumen, and the fixed points of the lifting sutures could just be felt. Re-examination 8 months later on September 9, 1925, revealed identical findings. There was no leucorrhœa, nor were there complaints of any kind referable to the pelvis.

The second patient operated upon by this method, Mrs. H., Case 135917, was an obese individual, aged 50. She was admitted to the Hospital on February 5, 1926.

The history in this case dated back 24 years to the time of her second confinement. Following this she first noted signs and symptoms of loss of pelvic support. Five pregnancies each with normal confinement followed. After each pregnancy her condition become worse. She suffered severely from frequency, urgency, dysuria, dragging pains, and difficulty in locomotion. It was necessary for her to push up the mass in order to empty the bladder or thoroughly evacuate the bowel.

Examination revealed a woman of average stature, but extremely obese, weight over 200 pounds. General examination was negative. Pelvic examination revealed a mass protruding approximately 5 inches from the vulva with complete prolapse of the uterus (Fig. 2). The entire uterus was outside the vulva and in a retroverted position. There was an enormous cystocele and moderate sized rectocele. The perineum was lacerated and quite markedly relaxed.

On February 11, 1926, the patient was operated upon. In this case a vaginal pan-hysterectomy was first done following which the procedure as outlined above was followed, except that the pubovesicocervical fascia was pleated rather than overlapped as in the first case and, secondly, a No. 7 braided silk rather than chromic catgut was used for the lifting sutures.

More difficulty was encountered in placing the lifting sutures in this patient because of her obesity.

The patient had a slightly febrile convalescence, but left the hospital with an excellent result. There was good support to the bladder and perineum. The vagina was long and readily admitted to their full length the index and middle fingers.

These patients were heard from in May, 1926, and both reported excellent health so far as the operative result is concerned.

In considering the operation, it would seem wise to discuss certain points of the technique more in detail.

It is obvious that the cases with sufficient length or hypertrophy of the vagina are best adapted for this method. The vagina must be long enough to bridge the distance to the posterior pelvic wall.

The fascia overlapping of the anterior vaginal wall for cystocele as done by Rawls, Bissell, and others gives excellent support to this viscus, but a simple pleating of the pubovesicocervical fascia may be substituted, if desired. This was done in the second case reported with excellent results. The particular method adopted will depend largely upon the amount of actual relaxation in this region and the operator's idiosyncrasies.

In placing the lifting sutures, care should be taken to secure sufficient fascial structure, for after all, it is the fascia that gives the real support, the sacro-uterine ligaments themselves being of value only in that they act as landmarks for the placing of these lifting sutures.

It is important that the free ends of the lifting sutures be placed far enough (at least 2 inches) apart when they are passed through the overlapped fascia. This spacing plus the natural stretching which occurs on tying the lifting sutures prevents possible constriction of the rectum.

The use of the non-absorbable suture such as the No. 7 braided silk used in the second case for the lifting sutures may be advisable. This would provide a more permanent fixation; and any inflammatory reaction which resulted from the use of a non-absorbable material of this kind might ultimately result in a more firm union and cicatrix formation. In the first case operated upon, No. 2 chromic catgut was utilized for the lifting suture and a very successful result was obtained.

In thin patients little difficulty should be encountered in placing the lifting sutures. In obese individuals, as in the second patient operated upon, this step may be more difficult. It is possible that much of this difficulty might be obviated by the use of a long bivalve speculum and a slight Trendelenburg position.

As in all new and untried procedures, there are faults to be overcome and minor difficulties to be ironed out. Possible disadvantages of the method described would appear to be few in number and of minor importance.

Damage to neighboring structures in placing the lifting sutures may be considered. Care in placing these sutures by the use of the index finger or a bivalve speculum as a guide minimizes this possibility. With the sacro-uterine ligaments as a guide the fixed point of the lifting sutures may be easily determined and the sutures placed without damage to neighboring structures.

Narrowing of the bowel lumen will be avoided if the technique given is closely followed. Sufficient space must be allowed between the lifting sutures so that no narrowing will take place.

The use of non-absorbable suture material as in the second case reported will undoubtedly result in localized inflammation and purulent leucorrhœa in some cases. This, however, might in the end result in a greater cicatrix and thus less chance of recurrence, but probably a real heavy chromic suture will best meet all requirements.

The possibility of recurrence exists in any operation for a lesion of this kind. Time alone will determine its value in this respect. It would seem, however, if a goodly amount of tissue is obtained in placing the lifting suture and if sufficient time is permitted for union, danger from this source is no greater than in other operations for complete inversion of the vagina or complete prolapse.

ADVANTAGES OF THE OPERATION

No conclusions are possible, but it seems only fair to mention advantages as well as possible disadvantages. Thus certain clearly defined advantages are:

1. A functional vagina with normal length and direction is produced.
2. The cystocele is corrected.
3. The rectocele and lacerated perineum are cured.
4. The operation offers a rational method of treating a complete inversion of the vagina occurring after panhysterectomy.
5. It offers a method of supporting the vaginal apex following vaginal panhysterectomy for complete prolapse.
6. It is not particularly difficult to perform.
7. All work may be done from below. No laparotomy is required.
8. The pelvic supporting mechanism is restored.

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CARCINOMA OF THE RECTUM AND RECTOSIGMOID

Factors Influencing the Choice of Operative Technique[1]

By LEO P. BELL, M.D., F.A.C.S., Woodland, California
From the Department of Surgery, Woodland Clinic

OUR knowledge of carcinoma from an etiological standpoint is limited. Maud Slye has proved that strains of mice can be made by selection to show a marked predisposition to the development of cancer while other strains can be made practically cancer-free. It seems entirely probable that certain individuals in the human race may also inherit a predisposition, in the nature of a cellular instability. Such an individual, when exposed to conditions, of which the irritative factor is one, may develop cancer. Carcinoma is known to arise chiefly in acid fields in the intestinal tract and in the lumen of the intestine and on those parts of the body which are subject to chronic irritation. When we depart from proved facts to speculate upon the origin of cancer, the most logical theory is that of undifferentiated fetal cells which have lost physiological control of differentiation. Broders made an exhaustive study of the microscopic grading of two thousand neoplasms seen at the Mayo Clinic from the years 1915 to 1919. He concluded that the grade of malignancy of a cancer depended upon the differentiation of the cells of the cancerous tissue, the grade of malignancy being higher if the differentiation was slight. He expressed this difference on a scale of one to four. McCarty has pointed out that cancers of the rectum vary in their rapidity of growth depending both upon their degree of cellular differentiation and upon the character of the reaction in the surrounding tissues, this reaction being the attempt of the organism to limit the growth of the neoplasm. He concludes that lymphocytic infiltration, fibrosis, and hyalinization are the factors which inhibit the rapidity of growth and dissemination. A neoplasm with all these factors present, together with a high degree of cellular differentiation of the cancer itself, gives the best postoperative longevity. It is common knowledge that the younger the individual, the more highly malignant will be the growth. This is by reason of the increased blood and lymph supply to the affected part and to the greater inherent power for growth in young cells.

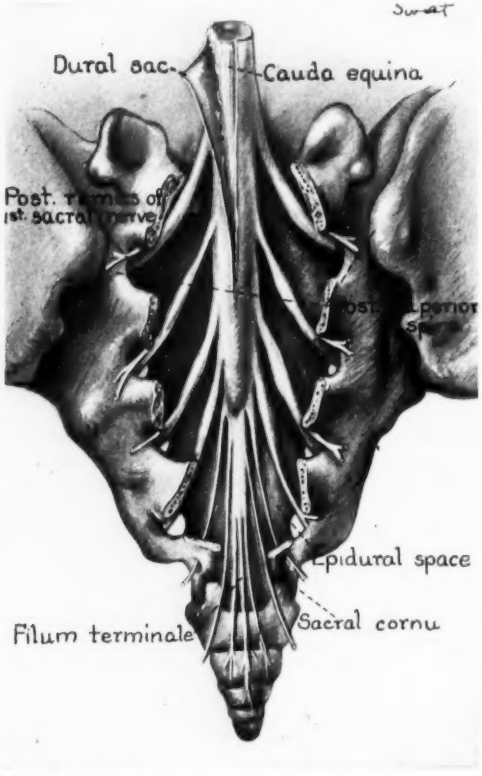

Fig. 1. Lamina and spines removed, exposing sacral canal which illustrates the space into which the novocain is introduced when a parasacral and epidural infiltration has been done.

The spread of carcinoma is chiefly by the lymphatics, frequently by the venous channels, and rarely by the arterial stream. Ernest Miles has made a most comprehensive and detailed study of the lymphatics of the rectum and of rectal drainage from a surgical standpoint. He mentions the following zones of lymphatic drainage:

1. The zone of downward spread, including the perineal skin, ischiorectal fat, and the external sphincter.

2. The zone of lateral spread, which includes the levators, rectorectal lymph nodes, those in

[1]Read beore the Utah State Medical Society, May 5, 1926.

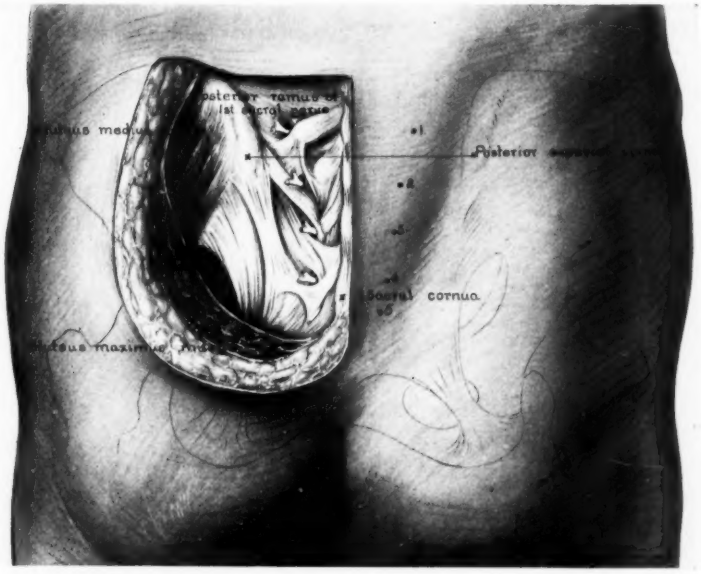

Fig. 2. Points 1–5 indicate the superficial sites of injection of parasacral infiltration. The fat and muscles have been removed, giving position of posterior superior spine and exit of posterior sacral nerves.

relation to branches of the internal iliacs, the prostate, the base of the bladder, the posterior vaginal wall, and the base of the broad ligaments.

3. The zone of upward spread: that is, the peritoneal floor of the pelvis, the pelvic mesocolon, the paracolic lymph nodes, and a group of glands at the bifurcation of the left common iliac artery. Miles mapped out these zones following a study of recurrences in four series of cases, the operation in each succeeding series being more extensive than in the preceding. The zones of upward and downward extension, as outlined by Miles, are of the greatest importance in determining the operation to be advised.

When carcinoma of the rectum and rectosigmoid is considered from the standpoint of radical operative cure of the disease, two salient points must constantly be borne in mind, namely, the immediate operative mortality, and the end-results as to recurrence and length of life following operation.

There is no type of operation which requires more careful thought than that for radical cure of carcinoma of the rectum. The surgeon must be familiar with at least three types of operative procedure and he must be guided in his choice by the following previously ascertained facts:

1. The location of the carcinoma, in centimeters, from the anal margin, to be determined by proctoscopic and digital examination, or by colon enemas.

2. The grade of malignancy (Broders' method) determined by biopsy before operation.

3. The determination, by careful physical and laboratory examinations, of the extent of any condition which will affect the immediate operative mortality, such as chronic myocarditis, arteriosclerosis, chronic nephritis, anæmia, loss of weight and strength, and toxæmia from obstruction.

4. The determination by abdominal exploration of the condition of the liver, retroperitoneal glands, and the glands of the rectal shelf. Upon the latter will depend the final judgment as to the operation of choice.

Unfortunately at the present time, surgeons are still divided in opinion as to choice of operative procedure. The men of the older school and a large number of English surgeons still cling to the type of operation exemplified by the following: Harrison-Cripp, Quenn-Tuttle, one-stage Kraske, excision of the growth with plastic closure, proctotomy, and cautery excision. Such operations have been devised as a result of the statistics by Hansemann of Vienna. He stated that carcinoma

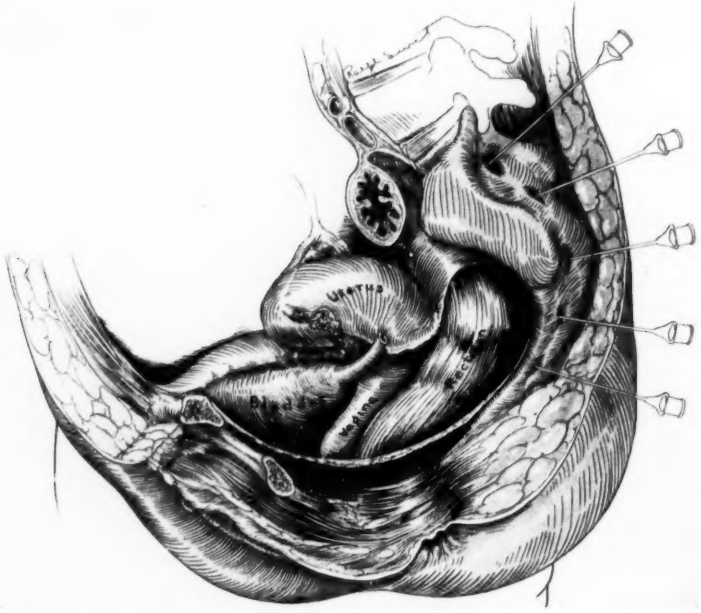

Fig. 3. The shaded area is the field of anæsthesia following epidural and parasacral infiltration. The anatomical relationship of the rectum to the pelvic viscera and bony structures of the pelvis is also illustrated.

was localized in the bowel wall in 55 per cent of 112 cases of carcinoma of the rectum upon which autopsies were eventually done. Without a doubt, many low grade malignancies, with little or no metastatic tendency, have been removed. In these cases the growth undoubtedly did not recur and these figures gave substantial basis for the opinion of the advocates of the one-stage operations. In addition, the natural repugnance to an artificial anus, as well as the lack of careful statistical study, added to the popularity of the one-stage operation. Miles' work has undermined the basis on which this popularity rested.

The controversy between the advocates of the radical two-stage abdominoperineal operation, the one-stage posterior resection operation, and the two-stage posterior resection operation has without question caused many needless deaths and has confused the statistics. To the end of saving these lives, it should be possible to standardize the procedure for dealing with carcinomata of the rectum and rectosigmoid. It should be possible to educate the layman to come for a yearly examination when in the cancer age. It should be possible to educate the practicing physician to do routine digital examinations of the rectum and to use the proctoscope when necessary. If these things could be accomplished, many of those who make up the 35 per cent of patients with inoperable carcinoma of the rectum would instead be in the operable class when first seen. Those who come in a precarious condition might have had the advantage of the abdominoperineal operation.

Immediate operative mortality varies with the experience of the surgeon and with the choice of operative procedure. Lockhart-Mummery and Gant report a series of cases of one-stage posterior resections which show a death rate of about 5 per cent. The Mayo Clinic reports a series of 312 cases of two-stage posterior resections with a death rate of 7.37 per cent. Jones states that the mortality for abdominoperineal operations is approximately 25 per cent, while Coffey reports a death rate of 4.25 per cent in a series of 47 cases. It is our belief that the two-stage abdominoperineal operations, as performed by the average surgeon, will result in a high mortality. The risk of the abdominoperineal operation, either one or two-stage, should not be taken if the grading of the malignancy is low or the condition of the patient is such as to raise the question of immediate

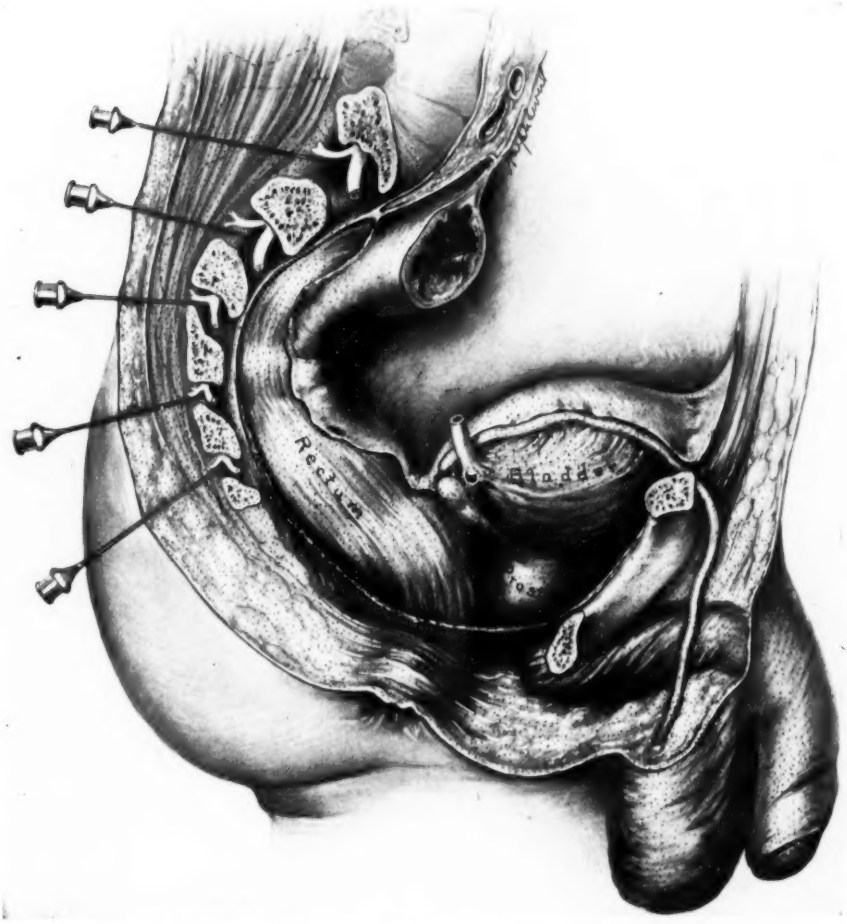

Fig. 4. The shaded area is the field of anæsthesia following epidural and parasacral infiltration. The anatomical relationship of the rectum to the pelvic viscera and bony structures of the pelvis is also illustrated.

survival from the operation. Conservation of the life of a patient, if from only 1 to 3 years, is of greater moment than the chance of a permanent cure by an operative procedure entailing great risk.

The statistics quoted by Jones show that in groups of cases of carcinoma of the rectum which have been operated on by advocates of the abdominoperineal technique, 11.3 per cent are living, without recurrence, at the end of 5 years. Only 4 per cent of patients in those groups operated on by the advocates of the one-stage perineal resection methods are living, without recurrence, at the end of the same period of time. In both instances the percentages take into consideration entire groups, including those patients in the inoperable stage. These statistics are, in a way, misleading. To be accurate, statistics must be compiled from the records of numerous surgeons and the factors of operative technique, postoperative care, and the skill of the surgeon must be considered. Most of these figures were compiled before 1915. Taking into consideration Miles' work, the two-stage operation of colostomy, followed by posterior resection, will show a much higher percentage of 5-year cures when the

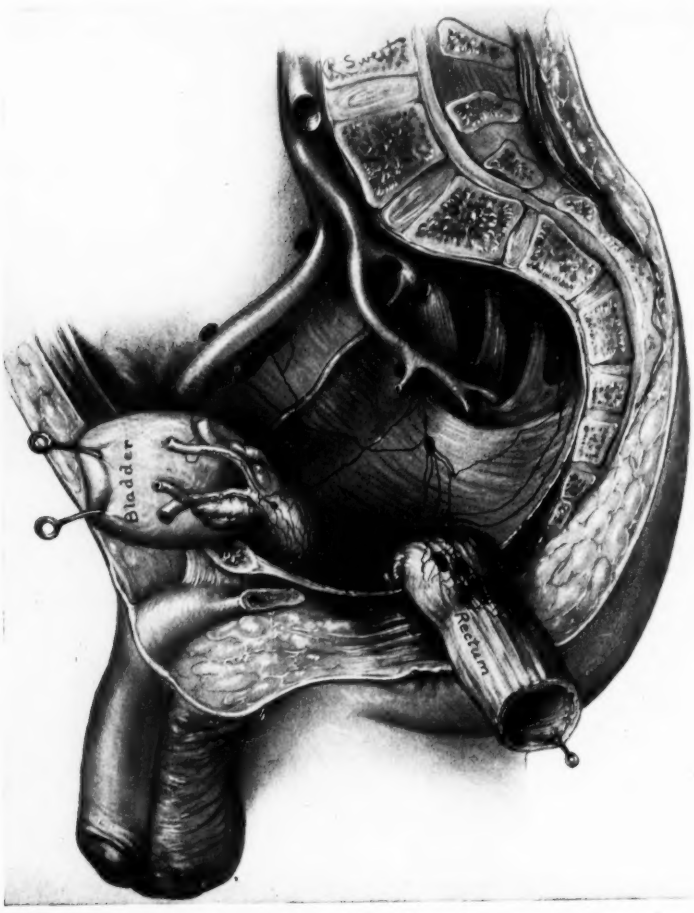

Fig. 5. The bladder, prostate, seminal vesicles, and rectum have been reflected from normal position, giving the deep lymphatic drainage of rectum and deep lymphatic communication with adjacent pelvic viscera.

statistics of 1920 to 1930 are summarized and a much better showing will be made both by posterior two-stage resections and abdominoperineal operations as a result of the more extensive knowledge of the disease, better technique, and more thoughtful choice of operative procedure.

Although the ideal operation, with respect to permanent cure, is generally conceded to be the one-stage abdominoperineal operation as devised by Miles, because of the very high immediate mortality the two-stage abdominoperineal operative technique has been evolved, thus securing a much lower death rate. This type of operation should always be the method of choice when the condition of the patient is such that the immediate risk of life is not too great or when the grade of malignancy is high. By Coffey's technique is secured the nearest approach to the low mortality considered ideal.

With the idea of reducing still lower the operative mortality and at the same time obtaining permanent cures, we have adopted, for any patient having a malignancy under Grade II or any extensive damage to heart, blood vessels, or kidneys, the permanent colostomy which is followed by posterior resection in 10 days to 2 weeks. Careful preliminary preparation is instituted by transfusions for the anæmic and debilitated, thera-

peutic attention to the damaged heart, kidneys, and blood vessels, and by careful cleansing of the large bowel to reduce existing toxæmia induced by obstruction and absorption from ulcerated surfaces.

The high posterior resection consists of the removal of the coccyx and the freeing of the rectum above and laterally wide of the growth. The anus is then removed with a wide block of tissue and muscles, including portions of the vagina or prostate, if there is attachment of the growth to these organs. The rectum is slowly brought down, care being used to keep widely away from the bowel walls, and amputated and invaginated from 6 to 8 centimeters above the peritoneal reflection. The lower end of the bowel is sewed into the upper end of the wound to facilitate drainage. The cavity is loosely packed with acriflavin gauze for 1 week, and later is irrigated daily with Dakin's solution.

If careful dissection of the rectal glands is done and care is taken to keep well removed from the growth, it is our opinion that the chance of leaving metastatic glands is not great. Certainly the risk of recurrence is less than the chance of immediate death from even the two-stage abdominoperineal operation when the condition of the patient involves any great hazard.

The third operation which should be considered is for the high rectosigmoid carcinoma which has produced so much obstruction to the lumen that an invagination cannot be done according to Coffey's technique. For patients suffering from this condition, the technique used at the Mayo Clinic is a low amputation of the rectum with the removal of the growth. The proximal end of the resected gut is then brought out to form a permanent artificial anus. The sphincter of the rectum is split to allow discharge of secretions.

Regional anæsthesia, by epidural and parasacral infiltration of 1 per cent novocain according to the method of Labat, is a most important factor in reducing the operative mortality. Operative shock, the dangers of lung complications, and decompensation of the heart are practically eliminated. Ernest Miles has reported a large series of cases in which this type of anæsthesia, used for the two-stage abdominoperineal operation, lowered the operative mortality from 25 per cent to 10 per cent. Lockhart-Mummery and the surgeons of the Mayo Clinic also advocate the use of regional anæsthesia.

When the operation chosen is that of preliminary colostomy under local or ethylene anæsthesia, followed by the removal of the coccyx and a high posterior resection under regional anæsthesia, the death rate is almost negligible. Because of its safety, this anæsthetic should also be used for the second stage of abdominoperineal operations.

The postoperative care of patients operated upon for carcinoma of the rectum is most important. All patients should be made to sit up within a week or 10 days. Cystitis frequently occurs and self-retaining urethral catheters should be used to allow frequent irrigations of the bladder until the patient is up and the inflammation has subsided. The use of deep roentgen therapy should be a routine procedure.

When we consider the lymphatics and their relation to the pelvic viscera, we are impressed by the fact that, if the grade of malignancy is high, no type of operative procedure can eradicate all points of possible metastasis, and it is the author's wish to emphasize the fact that, provided the type of operation best suited to the patient's physical condition is chosen, the grade of malignancy is the determining factor in a 5-year cure. Broders and McCarty express the opinion that the majority of cancers of the rectum are of Grade II.

Unfortunately, all of the patients reported in our series of cases came to us very much debilitated, so that in no case was an abdominoperineal operation deemed advisable. For each patient a preliminary colostomy was done followed, in 10 days to 2 weeks, by a posterior resection under regional anæsthesia. The reports are as follows:

Mrs. M., age 39. Duration of symptoms 1 month. Tumor, 8.5 centimeters from anal ring, Grade II plus. Colostomy was done on October 16, 1923, and resection on October 29, 1923.

Mrs. S., age 60. Duration of symptoms 1 month. Tumor, 4 centimeters from anal ring, Grade I. Colostomy on June 7, 1924, and resection on July 7, 1924.

Mr. R., age 57. Duration of symptoms 1 year. Tumor, 8 centimeters from anal ring, Grade II. Colostomy on October 4, 1924, and resection on October 20, 1924.

Mrs. B., age 32. Duration of symptoms 4 months. Tumor, 9 centimeters from anal ring, Grade II. Colostomy done on August 24, 1925, and resection on September 10, 1925.

Mrs. A., age 49. Duration of symptoms 2 to 3 months. Tumor, 4.5 centimeters from anal ring, Grade III minus. Colostomy done on September 12, 1925, and resection on September 26, 1925.

Mr. O., age 68. Duration of symptoms 8 months. Tumor, 4 centimeters from anal ring, Grade III minus. Colostomy done on November 25, 1925, and resection on December 10, 1925.

Though all of these patients were in a weakened condition when first seen, there were no deaths at the time of operation. This we attribute to careful preliminary preparation and to the use of regional anæsthesia. Sufficient time has not yet elapsed to determine what the final outcome will

be but, at the time of writing, none of the patients referred to has shown any evidence of recurrence of carcinoma, and we feel that the results of these operations will compare favorably with those achieved by the abdominoperineal technique because of the wide block of tissue removed, laterally and above the growth.

CONCLUSIONS

1. The one-stage posterior resection and abdominoperineal operations should be universally discarded.

2. The two-stage abdominoperineal operation is the method of choice when the grade of malignancy is high or when the physical condition of the patient is such that there is no appreciable operative risk.

3. The two-stage operation of colostomy followed by a posterior resection under parasacral and epidural anæsthesia results in a negligible operative mortality for patients for whom other types of operation would be very dangerous.

4. Carcinomata of Grades I and II minus, when 5 to 10 centimeters from the anal margin, can safely be dealt with by colostomy and posterior resection with an expectancy of life comparable to that offered by the abdominoperineal method without its high operative mortality.

5. The second stage of the abdominoperineal operation should be done under parasacral and epidural anæsthesia.

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A RECTO-ABDOMINAL MANEUVER FOR DETERMINING THE ENGAGEABILITY OF THE FETAL HEAD[1]

By ERNEST D. RESNIK, M.D., Brooklyn, New York

DESCENT of the head into the pelvic inlet, or engagement, is one of the most important phenomena of labor with which the accoucheur is confronted. A head is considered engaged in the pelvis when the biparietal diameter has passed through the inlet with the leading pole at a level with the ischial spines (1).

In a borderline pelvis with an unengaged head, the question of cæsarean section frequently arises. This problem requires the utmost nicety of judgment for its proper solution and at best it is not always accurately treated. Any method therefore which will help determine the engageability of a head should prove valuable, and at times a life saving measure (3).

In the discussion of this new method perhaps a brief review of the mechanics of labor will bring about a clearer understanding of the procedure. As the head lies in the inlet just before its entrance into the pelvis, if it is in a favorable position, the sagittal suture lies about midway between the promontory and the pubis. The head is then said to be in synclitism (Fig. 1.) The occipitofrontal plane lies parallel to that of the inlet. When conditions such as a pendulous abdomen or a contracted or faultily inclined pelvis are present, this relation is disturbed. In these cases the body of the fetus frequently falls forward, the sagittal suture approaches the promontory, and the anterior parietal bone becomes the leading pole. The parallelism between the occipitofrontal plane of the head and the plane of the pelvic inlet is lost. When this situation obtains the head is known to be in anterior asynclitism, Naegle's obliquity (Fig. 2). In like manner the head may be inclined on the inlet with the posterior parietal more to the front, producing a posterior asynclitism, Litzmann's obliquity (Fig. 2). The sagittal suture usually runs horizontally across the pelvis and in a multipara the small and large fontanels are frequently found on the same plane.

Contrary to the views of many authorities (2) who state that the head enters the pelvis in one of the oblique diameters, more frequently the right, De Lee (1) believes that the head enters transversely in the majority of the cases. Either view seems to be borne out by the fact that many more right posterior positions are being diagnosed than formerly. This position is the result of engagement in the right oblique at the onset, or a subsequent rotation from a transverse position to a right oblique, since an occiput rotates posteriorly more easily from a transverse than from an anterior position.

With descent of the head, flexion increases, the head acting as a two-armed lever with the fulcrum at the junction of the spine and the occipital condyles. The sinciput and occiput meet equal resistance in the birth canal, but the sincipital end of the lever is longer than the occipital end. Because of this the sinciput is held back and the occiput descends. The head adapts its smallest diameters to those of the birth canal by this process of flexion, the easiest manner of passage for the head thus being assured.

Any disturbance of the normal relation between the head and the pelvis will interfere with the engagement and descent of the head. A faultily inclined pelvis is often a cause. In a normal position of the pelvis with the woman in the erect posture, the promontory of the sacrum is 9.5 to 10 centimeters higher than the upper margin of the symphysis. The pelvic inclination, usually estimated at 45 to 50 degrees with the woman in the upright position, is that angle which the superior strait forms with the horizon. In a faultily inclined pelvis (due to kyphosis or lordosis) or in a high or low assimilation pelvis, this angle is either increased or diminished. Such a faulty plane gives rise to an asynclitism of the head and interferes with ready engagement, even though the pelvic measurements are ample.

The pelvic axis has been described as a line passing through centers of innumerable planes extending from the symphysis to the sacrum. At term the axis of the superior strait, if extended directly upward, would pass through the abdominal wall at the region of the umbilicus. Anomalies of this pelvic inclination may cause dystocia by influencing the direction of the uterine axis and thereby interfering with engagement. The downward driving force of the uterus upon the fetus is frequently wasted and may at times cause harm when the uterine axis is not in its proper relation to the pelvis. In these cases the leading part is not driven into the pelvis but impinges against a bone which retards its progress of descent.

[1] Read before the New Utrecht Medical Society, May, 1926.

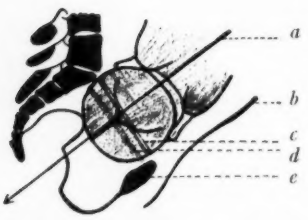

Fig. 1. Synclitism or parallelism. *a*, Uterine axis in line with axial direction of pelvis; *b*, abdominal wall; *c*, biparietal diameter; *d*, diameter of plane of inlet; *e*, symphysis pubis.

In this diagram the head is in synclitism, the occipitofrontal plane diameter being parallel with the diameter of the inlet. The uterine axis is in line with the axis of the pelvic inlet. Pressure downward on the breech from above will cause the head to descend further into the pelvis. Crowding the head into the pelvis by grasping the brow and occiput will have the same effect. The symphysis, iliac crests, or promontory of the sacrum do not act as points of impingement. The measurements of the inlet are assumed to be ample. (Modified from De Lee.)

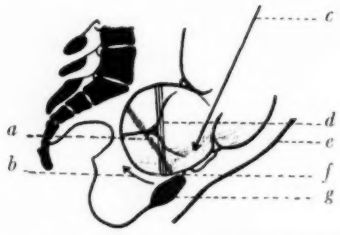

Fig. 2. Anterior asynclitism (Naegle's obliquity). *a*, Diameter of plane of inlet; *b*, resultant motion of presenting pole; *c*, uterine axis; *d*, biparietal diameter; *e*, abdominal wall; *f*, point of impingement; *g*, symphysis pubis.

In the above diagram an anterior parietal presentation is shown. The downward driving force of the uterus fails to advance the head into the inlet easily because of a lack of parallelism. The symphysis acts as a point of impingement making descent of the head into the pelvis difficult. Descent will take place after "leveling" of the head occurs, which usually takes place after the membranes have ruptured or after long labor. This type of presentation is apparently quite frequent and occurs most commonly in women with pendulous abdomens or faultily inclined pelves. It is in this kind of a case that the method described has its greatest value. (Modified from De Lee.)

With this understanding of the mechanics of labor the value of this recto-abdominal method for determining the engageability of the head is seen, whether it be early in labor or before labor begins. The usual methods of determining head engageability are valuable only under certain conditions. With the head resting at the brim, in synclitism, an impression of whether or not the head will engage may be obtained by applying downward pressure on the fundus, or by causing the head to conform with the pelvic inlet and then exerting a downward pressure on the axis of the inlet (Fig. 1). While this is being done, the rectal finger determines the degree of head descent. When the presenting part is not in synclitism,

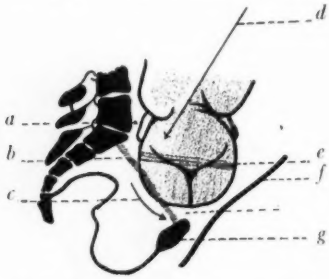

Fig. 3. Posterior asynclitism (Litzmann's obliquity). *a*, Point of impingement; *b*, diameter of plane of inlet; *c*, direction of motion of presenting part, *d*, uterine axis; *e*, biparietal diameter; *f*, abdominal wall; *g*, symphysis pubis.

A posterior parietal presentation is shown in the above diagram; here the baby's back actually arches toward the mother's back. In this sort of case it is necessary to start the maneuver with the hand over the flank either right or left, depending upon whether it is a right or left dorsal position. The purpose of this is to make an attempt to grasp the anterior shoulder which is actually in this region in cases of slightly contracted pelves. Primiparæ with slightly contracted pelves usually present this type of position. (Modified from De Lee.)

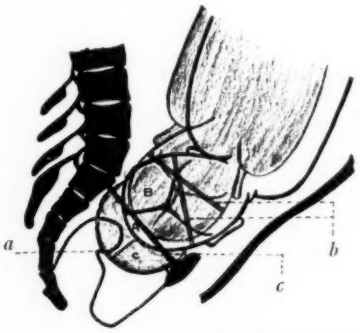

Fig. 4. Position of fetus before and after maneuver. *A*, Head in asynclitism—anterior parietal presentation; *B*, head brought into synclitism—biparietal diameter parallel with inlet diameter; *C*, head descending into pelvis indicating engagement. *a*, Ischial spine; *b*, biparietal diameter; *c*, diameter of pelvic inlet

By raising the anterior shoulder of *A*, the head is brought into parallelism with the pelvic inlet. Further pressure on the fetus in the direction of the mother's back causes the baby's back to straighten which in turn causes the head to advance deeper in the pelvic cavity. Finger in the rectum notes this advance.

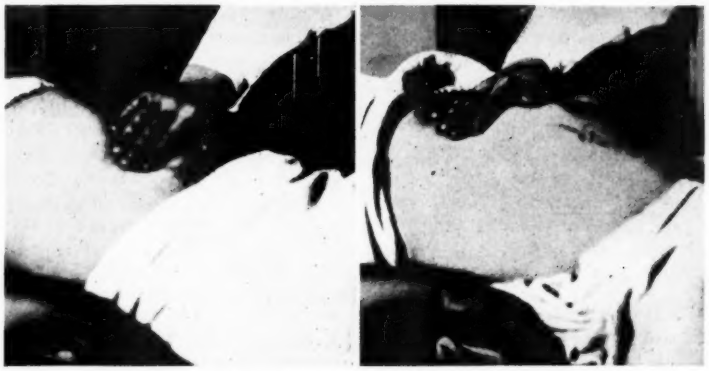

Fig. 5. Photograph. The palm of the hand is placed on the most dependent portion of the abdomen, usually over the bladder region, and as nearly over the anterior shoulder as possible. Rather forcibly the abdomen is raised upward toward the mother's head and at the same time the hand slides upward to a point just above the umbilicus. Then the force of the hand is directed strongly toward the mother's back.

The first maneuver tends to straighten out the head bringing it into parallelism with the pelvic inlet, while the second maneuver causes the head to advance into the pelvic inlet by straightening out the baby's back.

This last maneuver is the converse application of the principle that the baby's back straightens out as the head descends into the pelvis.

To obtain results, it may be necessary, particularly in cases of primiparæ with slightly contracted pelves, to start with the hand in the right or left flank, depending on the position of the anterior shoulder, as in these cases the baby's back is arched toward the mother's back.

lying either against the pubis or promontory of the sacrum, either of the above procedures may prove misleading. An attempt to crowd the head into the inlet does not always succeed and at times the leading pole recedes from the palpating finger.

Figure 2 demonstrates the action of the lines of force with the head in the oblique position.

Williams (3) states that despite the numerous methods devised for determining the size and engageability of the head, we are still without one that is thoroughly satisfactory.

To him Muller's "method of impression," Munro Kerr's method, and Pinard's "palper mensurator" are apparently the most valuable ones. According to Muller's method, the patient is anæsthetized, the brow and occiput of the child are seized with the fingers through the abdominal wall and firm pressure is made in the axis of the superior strait, the effect of which may be controlled by an assistant's finger in the vagina. If there be no disproportion the head will enter the pelvis and spontaneous labor may be predicted from the viewpoint of engagement. This method has some disadvantages and may at times, as shown above, give a false impression. It requires anæsthesia, the use of an assistant, and invasion of the vagina. In cases of marked asynclitism, unless the operator is skilled in this maneuver, the impingement of the leading pole against the bony inlet may not be corrected so that the lateral deflection attitude of the head is actually exaggerated and the leading pole recedes and becomes still further away from the vaginal finger (Fig. 2). Kerr's method also requires vaginal manipulation and is confronted with the same mechanical obstacles as Muller's. Pinard's method of crowding the head into the inlet to determine the amount of overriding on the symphysis involves too greatly the factor of personal equation and cannot be considered accurate.

By Ahlfeld's plan which is based on the belief that the biparietal diameter of the head bears a definite relation to the length of the fetus, the child is measured *in utero*. This is done by placing one blade of the pelvimeter upon the abdomen over the breech of the child, while the other is applied to the vertex *per vaginam*. From this measurement he calculates the size of the head based on his own table of computation. Other methods of computing the size of the head based on averages are used, but are not applicable to any individual case.

It is evident that some simple means of determining whether or not a head will engage is

desirable. According to many authorities when the conjugata vera is less than 7.5 centimeters, the problem is settled by resorting to a cæsarean section. When however it is greater than 7.5 centimeters, the method is not easy to decide upon as each case must be judged by its own merits. The degree of pelvic deformity, the size and consistency of the child's head, and the driving power of the uterine contractions are to be considered. The prognostic proficiency of the attending physician depends on his own skill and experience rather than on any fixed mathematical measure.

OUR METHOD OF DETERMINING THE ENGAGEABILITY OF THE HEAD

The position, presentation, and posture of the baby are determined and the anterior shoulder located. A finger is placed in the rectum to or just above the level of the ischial spines. The palm of the other hand is placed flat on the abdomen on its most dependent portion. Usually this is in the suprapubic region, and as nearly over the anterior shoulder as possible. With this hand this portion of the abdomen is raised upward toward the mother's head rather forcibly. As this is being done the hand slides slowly upward on the abdomen to a point just above the umbilicus where strong pressure is then exerted toward the mother's back (Fig. 4).

If the head is engageable it advances into the pelvic inlet, frequently as low as the ischial spines, and one can feel definitely certain it will engage in the course of labor. (Figure 4 demonstrates the mechanics of this procedure.) The first maneuver releases the head from any impingement and brings the axis of the uterus into parallelism with that of the pelvic canal, a principle utilized in treatment by raising or lowering the parturient's trunk. The disappearance of asynclitism results in the flexion and descent of the head, restoring the parallelism, and the sagittal suture approaches the middle of the pelvis. The second maneuver which consists of pushing the fetus dorsally toward the mother's back, tends to straighten out the baby's spinal column and causes further descent of the head into the pelvis. This is based on the principle that in the mechanism of labor as the head descends the back loses its convexity. Conversely then, it appears, that with the dorsal pressure applied to the abdomen, the fetal back tends to straighten out and causes the head to advance in the pelvis. Also, according to Sellheim, "the uterine contractions bring about important modifications in the attitude or habitus of the fetus which greatly facilitate the act of labor," and this is what we attempt to simulate in performing this maneuver. In primiparæ with slightly contracted pelves preventing engagement, it is usually necessary to start the first part of this maneuver with the hand in the right or left lower quadrant, approaching the flanks, depending on the location of the dorsum. The hand is placed as near the anterior shoulder as possible, which is usually in the flank in these cases, and the maneuver is proceeded with as before.

This procedure is most valuable in the multipara with a borderline pelvis, a pendulous abdomen, or a faultily inclined pelvis causing asynclitism which prevents engagement, either early or late in labor; and in the primipara with slightly contracted pelvis, occiput posterior position, and delayed engagement. In review, it is seen that the principle of this method is the same as that of the abdominal binder. The raising of the pendulous abdomen and the dorsal pressure exerted on the fetus caused by a binder has the same effect as this maneuver except to a lesser degree.

CASE REPORT

Mrs. S., age 34, with a borderline pelvis, was admitted to the Israel-Zion Hospital. Her first baby was delivered by cæsarean section. With her last baby she was in labor over 48 hours, dilatation was complete for about 3 hours, and the head was still unengaged. It was feared that if the membranes were artificially ruptured it might prove dangerous as the head might not engage and cæsarean section would have to be done. My method of testing the engageability of the head showed it to advance to the ischial spines. The membranes were then ruptured and the baby was delivered soon afterward.

In many other cases of multiparæ and primiparæ, both early and late in labor, when we have found by this method that the head advances into the inlet, the patient has been delivered from below.

SUMMARY

Since the known methods for determining the engageability of the head are apparently unsatisfactory, a safe and simple method is here presented with the hope that its use will relieve the general practitioner of anxiety in borderline cases and will aid the obstetrical surgeon in deciding whether cæsarean section is to be performed. The author greatly desires extensive application of this procedure, with reports on the results.

I wish to express my gratitude to Dr. David Feiner for his very helpful advice and cooperation and for the privilege of using hospital material.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D.....Managing Editor
ALLEN B. KANAVEL, M.D.....Associate Editor

WILLIAM J. MAYO, M.D.....Chief of Editorial Staff

APRIL, 1927

THE BIOLOGICAL ACTION OF LIGHT

LIFE is a dynamic relationship between structure and environment. The cell is the unit of life and is essentially a transformer of energy. In fact, the living cell may be regarded as a large electrified molecule surrounded by a shell of attendant positive or negative ions. The human body is a vast myriad of such cells: its covering, the skin, is everywhere studded with sensitive spots or eyes, and each of these groups of receptors is tuned to radiations of definite ranges of wavelengths. The influence of this reception of energy is conveyed internally to millions of cells situated in various tissues. This energy of radiation, largely from the sun, the great light "created in the beginning," changes matter, alters it and evolves it and endows it with new properties. "Untold millions of years ago, the sun's rays were impelling forces, as they are today. Under their influence, the facile carbon took on new and more complex forms as it built into its structure hydrogen, oxygen, nitrogen, sulphur, phosphorus, chlorine, sodium, potassium, calcium, magnesium, and iron." And the sun's rays have lost none of their efficacy or impelling forces; man today, just as much as ever before, is never free but always a slave to the light.

The mechanism of growth involves two things: one is an increase in the total amount of substance, and the other is a modification of substance, or differentiation of tissue. Growth and differentiation are not only independent but easily separated processes. We are certain that light, or any other form of radiant energy, cannot act unless it is absorbed. Rays which pass through a cell have no action on it. We know that we burn and tan in sunlight by reason of its ultraviolet content rather than because of its heat waves. The active ultraviolet rays penetrate to the deeper epidermal cells but no further. Ultraviolet light does not penetrate the organism far enough to reach the bones, for example, and hence it cannot be thought of as the agent which directly acts on bone tissue or which affects the growth or differentiation of tissues. Its stimulating action must therefore be transferred in some manner from the medium in which it is absorbed, the skin of the body, to the developing bone. In plants, for instance, we find that illuminating one portion of a plant affects the differentiation and development of all parts not exposed to the light. Since plants have no specialized nervous tissues and nerve systems to act as carriers, we may well conclude that photochemical products are formed in both plants and animals and that these photoproducts, or "formative materials" as some one has called them, bring about the differentiation. As Bovie has suggested, it is not impossible that the action of light on the blood stream is similar to that of

light on a photographic plate. On exposure of a plate to light, a latent image is formed which is due to photochemical reactions and which is ultimately developed and fixed with suitable chemicals to give the final image, or negative as it is ordinarily termed. Light acting on the blood stream produces photochemical reactions which may be conceived of as latent images in the blood: these in turn may be developed by the chemical interactions which occur in connection with the metabolic changes having to do with the differentiation of tissue.

From my experiments and those of my colleagues in The Mayo Foundation we know that ultraviolet radiation, such as is normally present in sunlight, tends to stimulate the endogenous growth of cells, accelerates the life cycle and therefore hastens death, whereas the longer wavelengths of light are necessary for exogenous development and the continuation of growth and repair of waste in the cell. The use of materials within the cell is hastened by ultraviolet radiations: the use of materials without the cell is inhibited in general by the short wavelengths but is accelerated by the longer wavelengths, such as those of the reds and the short heat waves. I am certain also of the fact that ultraviolet radiation increases the hatchability of eggs, including hens' eggs, and that, while the prenatal growth in hens' eggs under radiation is not sufficiently differentiated or enhanced to show any decided differences during the first ten days of incubation when comparison is made with the non-radiated, normally incubated eggs, still the prenatal radiation endows the hatched chicks with the ability to withstand for many weeks the onset of rickets when fed on a highly rachitic diet. In fact, they develop as well as do chicks which have not been prenatally radiated but which are fed on an antirachitic diet. We know from the experiments of Hughes and his coworkers that it may be possible to feed eggs from "sunkist" hens and keep the kiddies' legs straight. For if a hen lives in the sunlight or has been bathed in ultraviolet light she will lay eggs containing vitamin D. But if she has led a life under a glass house her eggs when fed to young growing chicks will not be valuable in preventing rickets. So, perhaps, to be well-born consists not only in the things of which the specialists in eugenics tell us but also in the resistance to the onslaught of untoward physical conditions built up in uterine days and set up by reason of the direct storage of energy or the products of the photochemical reactions produced by suitable forms and amounts of radiant energy. Perhaps our hot-house mothers would bear more robust and disease-resisting children if their diet included regular and regulated meals of sunshine and ultraviolet light.

Be these and other statements either truths, half-truths, or pure imagining and speculation, we do know that "from the day that we first open our eyes to the light, to the evening when, with drooped lids, 'into the night go one and all,' we are every hour literally turning to the light and its great source for ourselves and for our children; for our health, for our crops, for our flocks and herds; for the path of our ships on trackless seas, for guidance, for the hours of our toil and travel, in worship and in sacrifice." As the great physicist and chemist, Nernst, says: "The struggle for existence is, therefore . . . . not a struggle for fundamental material: the fundamental material for all organisms is present in excess in earth, air and water; it is not even a struggle for energy itself, for quantities of energy fill our environment in the inconvertible form of heat; it is a struggle *for the free energy available for work*, which the plant world stores up from the sunlight, as electrical energy is stored up in an accumulator." CHARLES SHEARD.

TOTAL OR SUBTOTAL HYSTERECTOMY FOR FIBROIDS

DURING the last quarter of a century there have appeared in the literature numerous articles advocating the abandonment of supravaginal hysterectomy for fibroids, and substituting therefor total hysterectomy or the complete operation. These articles have emanated from authors who had encountered one or more cases of cancer in the cervical stump after supravaginal hysterectomy for fibroids.

That fibroids predispose to cancer of the uterus is now universally acknowledged. Noble[1] reported one case of cancer of the cervix following supravaginal hysterectomy for fibroids. In the same year he reported also 100 cases of fibroid tumors in which hysterectomy was performed with an 8 per cent cancer incidence, 6 per cent being in the body and 2 per cent in the cervix. Currier[2] quotes Noble as stating that in 1,188 cases of fibroid tumors operated on by various surgeons, cancer of the corpus uteri was a complication in 29, 2.4 per cent; cancer of the cervix in 12, 1 per cent. Winter[3] reported 25 cases of cancer of the cervix occurring among 1,270 cases of uterine myoma, 2 per cent. Leonard[4] collected 3,786 cases of myoma of the uterus, in 124 of which there was coincident cancer of either the cervix or body, slightly over 3 per cent. Polak[5] quotes statistics of 900 cases of fibroid tumors of the uterus, from Schottlaender, Spencer, and Noble, in which undiagnosed cervical cancer was present in 2 per cent. Polak[6] was also able to collect 256 cases in which cancer occurred in the cervical stump after subtotal hysterectomy for fibroid tumors. Sidney Forsdike[7] reported 200 cases of cancer of the cervix, 5 of which occurred in the cervical stump following subtotal hysterectomy.

From the foregoing it is reasonable to expect that about 2 per cent of fibroid uteri will have coexistent cancer of the cervix. It probably is also reasonable to expect that 2 per cent of the diseased cervical stumps left after supravaginal hysterectomy will develop cancer in later years. But it probably is not reasonable to expect that 2 per cent of normal cervical stumps will develop cancer.

The arguments advanced in favor of the supravaginal operation as a routine are: (1) It has a lower mortality. (2) The operation can be performed more rapidly and with less surgical shock. (3) There is no vaginal shortening, a matter of considerable importance to a married woman. (4) There is less likelihood of prolapse of the vaginal walls. (5) There is less chance of injuring the ureters, bladder, or rectum, hence lower morbidity. And (6) There is less danger of infection (by cutting across the cervix than by opening the vagina). (7) Moreover, those who favor supravaginal hysterectomy as the routine procedure hold that the number of cancers developing in the remaining cervical stump can be reduced by not leaving a cervix diseased.

The arguments advanced in favor of the complete operation are: (1) The mortality is only a little higher than in the subtotal. (2) The total operation is no more difficult and it takes no longer to be performed. (3) By removing the cervix the morbidity is less. It is stated that frequently after the supravaginal operation a lacerated or infected cervix causes metrorrhagia or leucorrhœa and that this constant irritation invites cancer development. (4) In the properly performed total operation there is no vaginal shortening; and if care is exercised in the suturing of the supporting ligaments to the vaginal vault,

[1] Am. J. Obst., 1906, liv, 77.
[2] Am. J. Obst., 1906, liii, 831.
[3] Ztschr. f. Geburtsh. u. Gynaek., 1906, lvii, 8.
[4] Ann. Surg., 1913, lviii, 373.
[5] New York State J. M., 1921, xxi, 45.
[6] J. Am. M. Ass., 1920, lxxv, 579.
[7] Brit. M. J., 1924, ii, 94.

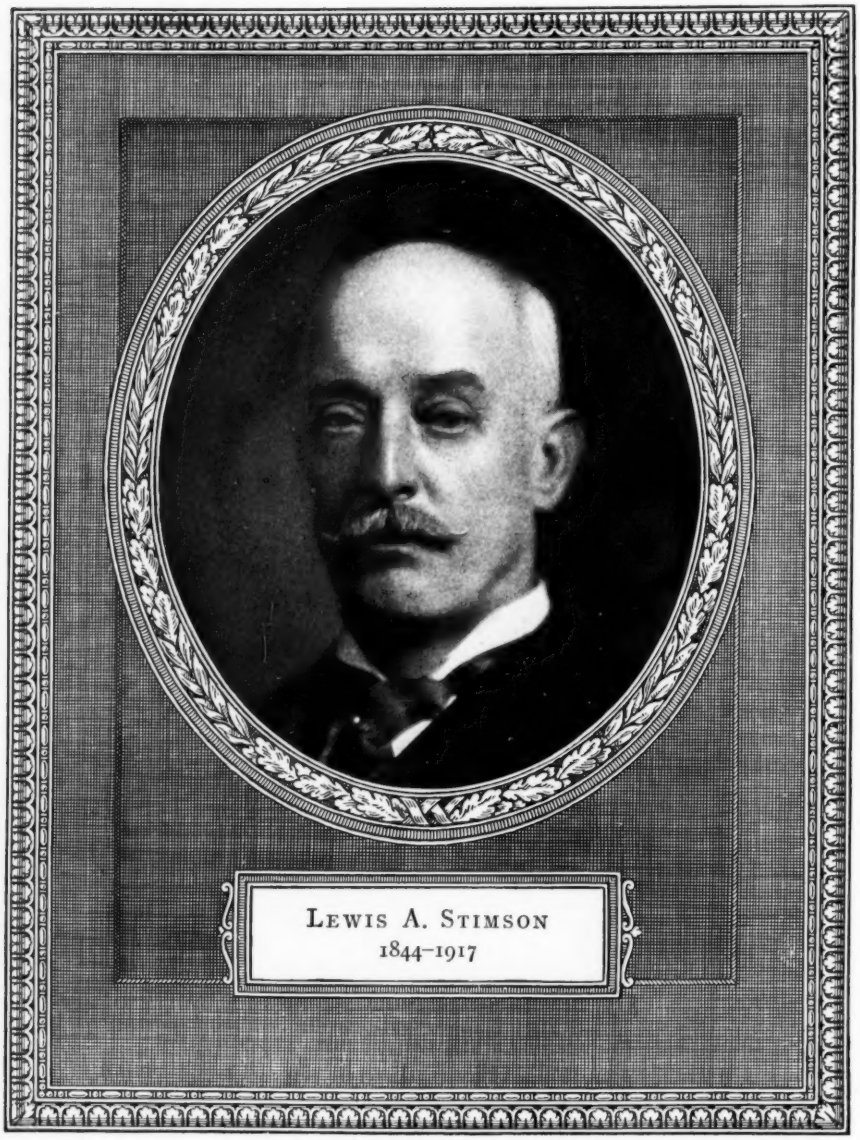
and proper perineal repair is done when indicated, there is no more probability of vaginal prolapse in the complete operation than in the supravaginal. (5) There is no greater danger of infection if the vagina is properly prepared.

When we are considering the preceding arguments it is well to have in mind the mortality statistics of the two operations which have been variously given as from 1½ to 2 per cent in the supravaginal operation and from 2 to 6 per cent in the complete operation.

If it could be conclusively shown that total hysterectomy would carry a mortality rate lower than the cancer incidence of the cervical stump, then the complete operation would rationally be the procedure of choice. However, as every casual operator performs operations for fibroids of the uterus, the substitution of complete hysterectomy for the supravaginal procedure would at once greatly increase the mortality. It is admitted that there is a 2 per cent incidence of cancer of the cervix in uterine fibroids which complete hysterectomy would cure, yet there is a doubt if complete hysterectomy routinely done by the average operator would reduce the number of total deaths. That is to say, there would probably be more deaths from the operation than from the disease the operation was intended to prevent. While a very few master surgeons may have developed so refined a technique as to have no more than a fractional higher mortality in the total operation than in the subtotal operation and no greater morbidity from accidents, still such a degree of skill is not possessed by the majority of surgeons doing hysterectomies.

It seems to me that in a case of fibroid uterus, when hysterectomy is indicated, the cervix should be carefully examined and if it is found deeply lacerated and infected or apparently suspicious, the complete operation should be done. If the cervix is normal, or one which may easily be made normal, with not very deep lacerations or with mild erosion, then the supravaginal operation may be performed, after the cervical pathological condition has been corrected. In those cases in which supravaginal amputation is contemplated, whether or not there has been metrorrhagia, I deem it wise to curette immediately before opening the abdomen, and to have the scrapings examined by a competent pathologist whose report should be had by the time the uterine arteries are tied. If his report is negative for cancer the supravaginal operation is executed; if it is positive the complete operation is proceeded with. Another precaution which should never be neglected in supravaginal amputation is to examine or have examined the uterine cavity immediately after the corpus uteri is removed. If a suspicious area is present the cervix may then be excised at once. By following this course one avoids committing too frequently the error of performing an incomplete operation in those cases of coexistent fibroid and cancer. This procedure I believe protects the patient reasonably well from subsequent cancer of the cervix, and also safeguards her against a more hazardous operation than the circumstances warrant. MAURICE KAHN.

UNIV OF MICH



LEWIS A. STIMSON
1844–1917

MASTER SURGEONS OF AMERICA

LEWIS ATTERBURY STIMSON

LEWIS ATTERBURY STIMSON, born August 24, 1844, in Paterson, New Jersey, was descended from the earliest settlers in this country. His father's family were among the settlers of the second Massachusetts Bay Colony and his mother's family were of old Huguenot stock. Both families were active participants in the American Revolution.

At the age of 18 he graduated from Yale University in the class of 1863. In 1864 he enlisted in the Union Army and was an aid upon the staff of General Birney and later upon the staff of General Terry. His Civil War memories written during his maturity (1924) contain one sentence which is illuminating in the light of our present post bellum demoralization. Speaking of war in general he writes—"'War is Hell,' but the hellishness is not simply the slaughter and the physical destruction, it is also the corruption of character, the loosening of moral bonds, the utter disregard of right and wrong."

Following the Civil War he engaged in business on the Stock Exchange but during this time, in association with a young medical friend, he was interested in certain pathological problems which finally aroused his interest to such an extent that in 1871 at the age of 27 he began to study medicine. In 1871 he went to Paris where he studied under such great teachers as Pasteur, Nélaton, Robin, Cornil, and others. In 1875 he was graduated from the Bellevue Hospital Medical College. He was professor of physiology in the New York University Medical School from 1883 to 1885; professor of anatomy from 1885 to 1889; professor of surgery from 1889 to 1898. In 1898, largely due to his efforts, the Cornell Medical School was established and he became its first professor of surgery.

From the beginning of his professional career his scientific contributions were numerous. Among these were, *Operative Surgery, A Treatise on Fractures and Dislocations*, which will always remain a classic upon this subject. Among his other important contributions to surgical knowledge were (1) the ligation of the ovarian and uterine arteries in sequence in their course in hysterectomy (1889), a step which Kelly considers placed the modern operation upon a safe basis; (2) the introduction and popularization of the moulded plaster splint in the treatment of fractures; (3) methods of reduction of dislocations at the hip and shoulder

(1888); (4) combined traction and suspension (Hodgen-Stimson) in fracture of the femur; (5) the treatment of old dislocation of the elbow . . . in this he was the first to draw attention to the newly formed bone on the humerus as the obstacle to reduction . . . , and (6) the use of the transverse incision as an approach to the abdominal contents. Pfannenstiel's article appeared in Germany before Stimson's article was published in this country, but Stimson evidently antedated Pfannenstiel in the use of the method.

He was in the course of his professional career, attending surgeon to the Presbyterian, Bellevue, and New York Hospitals, and the Hudson Street Hospital (New York Hospital House of Relief), and served 22 years on the staff of the latter two hospitals as an active surgeon. Later he was consulting surgeon to Bellevue, New York Hospital, and Christ's Hospital in Jersey City. In conjunction with Dr. Van Buren he founded the New York Surgical Society. From 1893 to 1896 he was vice-president of the New York Academy of Medicine. He was a member of the Société de Chirurgie of Paris and regent of the State of New York, 1893 to 1904. In 1900, Yale University conferred upon him the degree of LL.D.

Dr. Stimson was an enthusiastic sportsman as evidenced by his love for his yacht, the "Fleur de Lys," in which he made many cruises to the Mediterranean, Iceland, and elsewhere. His little vessel of 90 tons was seventh in the ocean race of 1905 for the Kaiser's cup, and his eyes sparkled with delightful memories when he described the remarks of his captain, Tom Bohlen of Gloucester fame, when the latter instructed a timid mate "to carry all sails as long as the sticks hold."

As a teacher Stimson was inspiring. His method was direct, easily understood, logical, analytical, and practical. No necessary detail was too small, but no unnecessary detail was added to lay emphasis. His insight into his subject was remarkable and few of his students found his courses anything but absorbing. His enthusiasm and his interest carried them with him. To those whose privilege it was to be associated with him in the hospital, "Stimmy" to the staff and nurses, his presence was always an inspiration and his rounds were always well attended. His relation to his staff was a personal one and his help and advice given without stint. His analysis of the cases before him was clear-cut and incisive and he had to a very marked degree that keen decisive clinical insight which separates the essential from the non-essential. To the junior members of the staff he never grew old; to them he gave sympathetic advice and instruction and more than one young house officer has given voice to the sentiment, "Stimmy looked at that just as I did and, gee, it was a help to have him show me the solution of my difficulty." He was frank, honest, kindly and sympathetic and perhaps the old Irish woman's reply to his question—"And how are you today?"—"Sure, and with your attention and kindly presence, how could I be other than better?" explains more readily than any words his relation to his patients.

To have gained his friendship was to be admitted to an inner circle where dwelt kindly sympathy, an earnestness of purpose in the pursuit of truth, and a devotion to fact which was always an inspiration.

Doctor Stimson died September 17, 1917, while out walking with his dog on the Shinnecock Hills.

"The Legend of Felix is ended, the toiling of Felix is done;
The Master has paid him his wages, the goal of his journey is won:
He rests but he never is idle."

JAMES MORLEY HITZROT.

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

By ALFRED BROWN, M.D., F.A.C.S., Omaha, Nebraska

THE MEDICAL DICTIONARY OF HENRICUS STEPHANUS

In the sixteenth century medicine and surgery greatly lacked solidarity and unanimity of expression of ideas. This was, of necessity, to be expected, as the expression of medical thought by means of the printed word had been in existence for less than a century, whereas the workers who had served to originate that thought had lived over a period of nearly two thousand years and had published their ideas in numerous languages. Consequently, if one physician followed the Arabians, for example, his terminology might be totally incomprehensible to one who had followed the Greeks and as for the one who followed the vernacular his terminology was a mixture of everything extant. Latin had been for many years the standard language of medicine but the words and ideas of the ancients had not all been translated into that language, and even the works written in that tongue borrowed their nomenclature of disease from whatever author they happened to be conversant with without regard to the language. It was about time for a lexicographer to take a hand and attempt to straighten out the muddle, and Henricus Stephanus supplied the need. Looking back from the vantage point of nearly four centuries one could hardly have chosen a better man for the task. Born of a family of printers and literati, Henricus Stephanus or Henri Estienne represented the highest type of linguistic culture of his time. His grandfather, Henri Estienne the first (died 1520), had come to Paris from Provence in 1502 and soon founded the printing establishment which for years bore the latinized form of the name "The Stephanus Press." Henri's second son Robert (1503–1559) succeeded to his father's establishment in 1526. The press had been carried on after his father's death by his step father, Simon de Colmes, who had been the foreman and had married Henri's widow. Robert was the member of the family who adopted the familiar printer's mark of the press, the olive tree. He was an excellent linguist and became the King's printer for Hebrew and Latin. However, he became involved in Ecclesiastical controversies, joined the reformed church, and later in 1551 left Paris, practically being driven out, and founded the press at Geneva. Robert's brother Charles studied medicine and took his degree at Paris. He was a pupil of Sylvius and his anatomy published in Paris, in 1545, was really in part pre-Vesalian for some of it had been prepared as early as 1530. Charles continued the Paris branch of the press after his brothers departure for Geneva but did not succeed as he became bankrupt and died in prison. Robert's son, the second Henri Estienne, was educated as a linguist. Because of the many nationalities of the workmen at the press, Latin was the language used by all, consequently it became practically his mother tongue. Greek, he took up as a serious study with Pierre Danès, the foremost Greek scholar in France, and later attended lectures of other famous linguists. He also learned Spanish. In 1547, when sixteen years of age, he began to hunt for manuscripts, and this carried him to Italy, England, and Flanders, where he not only found and collated rare manuscripts but also came in contact with the most learned linguists of the different countries. Returning to Geneva he set up his own press in 1557, with the assistance of the wealthy Augsburg Merchant Huldrich Fugger, and began to publish the results of his research. In 1559 his father died and the two presses were united.

The principal medical work of this non-medical savant was his *Dictionarium medicum, vel expositiones vocum medicinalium* etc. published in 1564.[1] It is a veritable marvel of lexicography. Stephanus went over manuscripts word by word, compared the different meanings and interpretations placed on words by the authors, and, finally deciding on a definite terminology, translated the meaning into Latin and then gave the definition of the term. Such a task was monumental and one wonders that he was able to complete it in six years, as he states in his preface written to his friend Philibertum Saraoenum, a physician. It was necessary for him to consult the manuscripts of the different authors that he names (see illustration) and carefully note the differences between their use of terms. When one considers the number of hands through which these manuscripts had passed and the number of times they had been rewritten and changed one wonders that he had the courage to attempt the work. When, however, one notes the excellent definitions of such pathological conditions as epulis, paronychia, pitiriasis, parotid abscess, angina, and others, one cannot but believe that this work of Stephanus' must have exerted a considerable influence on the standardization of medical terminology.

[1] Courtesy of the Library of Nebraska University, College of Medicine.

DICTIONARIVM medicum,

Vel, EXPOSITIONES VOcum medicinaliũ, ad verbum excerptæ

Ex HIPPOCRATE,	AETIO,
ARETAEO,	ALEX. TRALLIANO,
GALENO,	PAVLO AEGINETA,
ORIBASIO,	ACTVARIO,
RVFO EPHESIO,	CORN. CELSO.

Cum Latina interpretatione.

LEXICA duo in Hippocratem huic Dictionario præfixa ſunt, vnum, EROTIANI, nunquã antea editũ: alterũ, GALENI, multo emendatius quàm antea excuſum.

AN. M. D. LXIIII

Excudebat Henricus Stephanus, illuſtris viri Huldrici Fuggeri typographus.

Mich. Richay. 1705.

REVIEWS OF NEW BOOKS IN SURGERY

THE tenth pamphlet of *La Pratique Chirurgicale*[1] *Illustrée* is at hand. The text is by various authors who are acknowledged authorities in their fields. As in the previous pamphlets the great value lies in the drawings of Dupret. These drawings depict with remarkable clarity the various stages of the operations described. Although drawn from life, and although retaining the normal proportions, the illustrations are extremely simple and in few lines demonstrate that which the author wishes to show.

It is too bad that the subject matter in the pamphlets is not selected with more attention to arrangement. As it is now there seems to be no rhyme or reason for the sequence; a description of an operation of the gall bladder is followed by a study of some phase of gastric surgery, which in turn is followed by a description of the operation of phrenicectomy.

Properly arranged these pamphlets, with the excellent illustrations of S. Dupret, would surpass anything the reviewer knows in the field of a text on operative surgery. RALPH B. BETTMAN.

THE monograph, *Cancer of the Œsophagus*,[2] by Bérard and Sargnon, is one of a collection of monographs on cancer of various organs published under the direction of Hartman and Bérard. It contains about 500 pages, 75 illustrations, and over 600 references to the literature, and is an excellent compilation of our present knowledge of the disease. The anatomy, the pathology, the symptomatology, and diagnosis are dealt with at length. The chapter on treatment indicates in greater or less detail the forms of therapy which have been advanced. The monograph contains little that is new, but as a collection of known facts it is to be highly recommended. RALPH B. BETTMAN.

THE sixth volume[3] of the *Travaux de Chirurgie* is devoted to surgery of the stomach. It is written by the venerable dean of French surgery, Henri Hartmann, in collaboration with several coworkers. The volume contains 334 pages of text and numerous illustrations. It reflects the experience and the opinions of a master surgeon, himself one of the pioneers in the field of surgery. There are chapters on diagnosis, operative technique, peptic-jejunal ulcer, malignant and benign tumors of the stomach, etc. An exhaustive bibliography adds much to the value of the book.

Hartmann feels that if the surgeon wishes to be more than the barber of yesterday, he must master the symptomatology of gastric disease. The surgeon has an advantage over the internist in that he can verify his observations on the operating table, whereas the latter sees his errors only at autopsy. He regrets the modern tendency of relying upon the laboratory aids almost to the exclusion of personal examination of the patient. While not underestimating the importance of the laboratory, he feels that a carefully taken history plus such ordinary tests as are within the reach of every physician, would permit one without recourse to the laboratory to make a correct diagnosis in a very large proportion of all gastric cases.

Hartmann favors the addition of gastro-enterostomy to the suture of perforation in the treatment of perforated ulcers. He rejects gastric resection for these cases because of a considerably higher immediate mortality. Gastro-enterostomy is indicated when the patient's condition is good, when the perforation has been present not over 12 hours, when the ulcer is much indurated, and when simple closure of the perforation is likely to lead to stenosis.

The technique of operations upon the stomach is dealt with in detail and is in the reviewer's opinion the most valuable part of the book. The history, evolution, and rationale of every procedure is given an adequate presentation.

It is interesting to note that Hartmann is an ardent defender of gastro-enterostomy as the method of choice in the treatment of not only the duodenal ulcer but likewise of the ulcer of the body of the stomach and of the lesser curvature. On the basis of experimental radiological studies only, he denies the contention of certain authors who claim that the gastro-enterostomy stoma ceases to function sooner or later.

The immediate mortality in a group of 842 gastro-enterostomies performed for cancer on peptic ulcer was 17.24 per cent. A follow-up study was made of a group of 187 gastro-enterostomies performed for peptic ulcer.

He disagrees with the advocates of extensive gastric resection, because he has obtained excellent results by gastro-enterostomy. His own experience coincides with that of Roux and of A. Kocher. The cases with pyloric stenosis gave the best results. Ulcers of the body and of the lesser curvature gave almost as good results. In only 10 cases of the series did reoperation have to be done. Gastro-jejunal ulcer occurred 3 times. Malignant degeneration of a gastric ulcer was a rare occurrence as it was observed in only 4 of this series.

Failures are to be ascribed either to a faulty diagnosis or to faulty technique. He particularly warns against placing the stoma too far to the left. There is one type of case in which gastro-enterostomy does not give satisfactory results, that is one with extensive adhesive perigastritis. Fortunately these cases are rare.

[1] LA PRATIQUE CHIRURGICALE ILLUSTRÉE. vol. x. By Victor Pauchet. Paris: Gaston Doin et Cie, 1927.

[2] CANCER DE L'ŒSOPHAGE. By L. Bérard and A. Sargnon. Paris: Gaston Doin et Cie, 1927.

[3] CHIRURGIE DE L'ESTOMAC (PREMIÉRE PARTIE). By Henri Hartmann. Paris: Masson et Cie, 1926.

One of the frequent sources of recurrence is neglect of dietetic régime. Histological studies of resected ulcers showed an extensive inflammatory gastritis. For this reason medical postoperative treatment must not be neglected.

GEORGE HALPERIN.

A TEXTBOOK of embryology[1] by Jordan and Kindred constitutes an important addition to Appleton's medical text series. The authors' names are a sufficient guarantee that this is a solid and reliable work. The manner of treatment is traditional and there are no novel features despite the statement in the preface that the inclusion of a brief section on laboratory studies is such. The descriptions are clear and uniformly abreast of the times with many—and possibly from the student's standpoint, too many—references to recent literature. The typography is good and the illustrations are abundant and adequate although the many redrawn ones and most of the originals do not equal either the standard borrowed figures or those taken from recent publications; the free-hand lettering, not especially well done, detracts from the pleasing appearance that modern standards demand.

At the end there is a collection of undescribed illustrations showing various stages of development in the usual laboratory animals. These will be of help to the student who has serial sections to interpret and instructors at hand to aid. It is doubtful, however, whether it will fulfill the authors' hope of serving as a substitute for laboratory experience to physicians who never had such. Embryology is a three-dimensional subject and its study is a continuum; unexplained, discontinuous levels can at best reorient students with serial sections before them.

L. B. A.

AS anatomy was the division of medical science which piqued the curiosity of mankind in the early days it is eminently fitting that the first volume of an atlas of the history of medicine[2] should deal with that subject. Dr. De Lint has endeavored by means of illustration to pass before the seeing mind of the reader a procession of the most important events in the development of anatomy from its earliest beginnings up to the beginning of the twentieth century. In this task the author has achieved his object. The illustrations are well chosen to bring out the desired points and the volume gives an excellent idea of the gradual growth of anatomy not only as anatomy itself but also in its relation to the other sciences, particularly physiology. Harvey's work on the circulation of the blood receives a prominent place. Possibly one might wish that the relation of anatomy to the primal urge of early days to discover more of the origin of life by means of illustration of the internal genitalia had been given a more prominent place by the inclusion of some of the early fugitive sheets dealing with this subject but probably the author may be saving this phase for a subsequent volume. The format is good and the illustrations are excellent reproductions of subjects which are not easy to copy clearly.

ALFRED BROWN

A LITTLE book of 70 pages divided into ten chapters covers the usual subjects of diabetic management.[3] The exposition is rapid and would be clear to the educated patient. The food lists are short, being intended as illustrations, and four daily menus are given. Although very brief, the text is rather complicated. The happiness of the healthy diabetic as compared to the purgatory of those uncontrolled is expressed but is not stressed.

PAUL STARR.

IN a book on physical therapy[4] in diseases of the eye, ear, nose, and throat, the authors devote the first third of the text to a description of various appliances for the use of electrical energy. The description is simple and clear regarding the application of the various forms of electricity and light. However, some of the statements would seem rather broad and without sufficient proof to warrant adaptation by scientific men in medical work.

That the work has merit is true. Furthermore it places before the medical profession the uses and dosages of electricity in this specialty. The proper application of the ultraviolet ray is also presented. The type of current and the amount of current has apparently been completely worked out. Caution is shown in the suggestions of the beginning short exposure with a gradual non-detrimental increase although in some cases a heavy dose far beyond the usual is used but only by being gradually increased with careful observation. This is beneficial but overenthusiasm rather than sound judgment has apparently dictated some of the results as stated. The proofs of certain claims are lacking.

The authors should be congratulated upon bringing before the profession in concise form the effect of electricity and the ultraviolet light in this specialty, but it will take many cases with carefully recorded findings to instill confidence into the minds of scientific medical men.

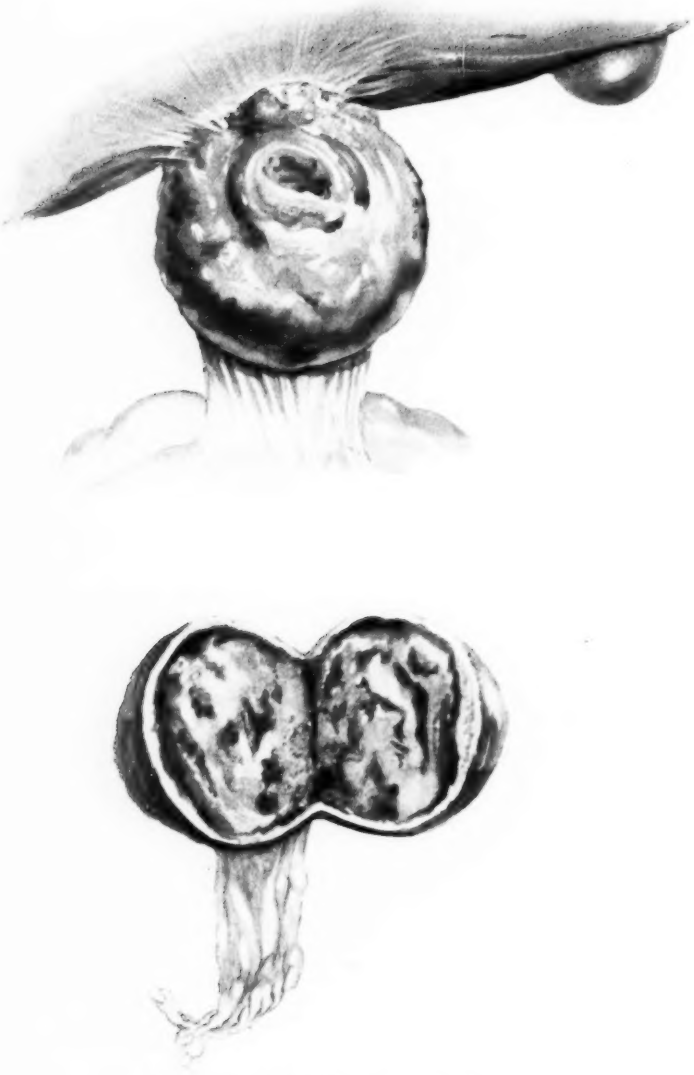
MONCRIEFF.

[1] A TEXTBOOK OF EMBRYOLOGY. By Harvey Ernest Jordan, A M., Ph.D., and James Ernest Kindred, M.A., Ph.D. New York: Appleton and Company, 1926.

[2] ATLAS OF THE HISTORY OF MEDICINE. I. ANATOMY. By Dr. J. G. De Lint, Lecturer on the History of Medicine at the University at Leyden. With foreword by Charles Singer. New York: Paul B. Hoeber, Inc., 1926.

[3] SELF-CARE FOR THE DIABETIC; FOR THE USE OF DIABETIC PATIENTS. By J. J. Conybeare, M.C., M.D. (Oxon.), F.R.C.P.(Lond.). London and New York: Oxford University Press, 1926.

[4] PHYSICAL THERAPY IN DISEASES OF THE EYE, EAR, NOSE, AND THROAT WITH CHAPTERS ON SOME BORDERLINE AFFECTIONS. By Charles R. Hollender, M.D., and Maurice H. Cottle, M.D. New York: The Macmillan Company, 1926.



Calcified hydatid cyst of the liver, natural size.

Hydatid Cysts of the Liver.—H. W. Mills.